

NYASALAND PROTECTORATE



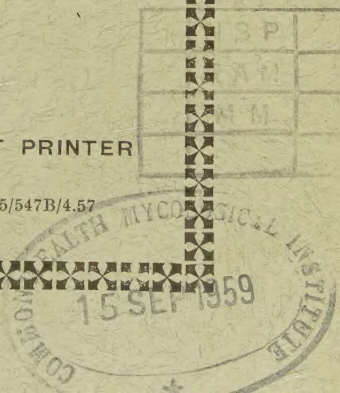
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ANNUAL REPORT FOR THE YEAR 1955/56

(PART II)

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Appendix—Map showing Experiment Stations and Cash Crop Areas

LIST OF EXPERIMENT STATIONS AND STAFF LIST

The experiment stations in operation, during the period under review, and the officers who have been in residence are listed below:—

Agricultural Research Station, Chitedze, Box 158, Lilongwe

Chief Agricultural Research Officer	..	..	..	S. T. HOYLE
Agricultural Officer (Tobacco)	..	..	..	J. F. CONROY
Agricultural Officer (Agronomist)	..	..	..	P. BROWN
Plant Breeder	..	..	..	R. T. ELLIS
Agricultural Chemist	..	..	..	R. A. WOOD
Assistant Chemist	..	..	..	W. D. CHONA
Farm Manager	..	..	..	P. F. LARKINS

Tea Experiment Station, Mimosa, Mlanje

Senior Tea Research Officer	..	..	..	D. L. DOWNIE
Tea Research Officer	..	..	..	D. H. LAYCOCK
Horticulturist	..	..	..	I. P. SCARBOROUGH
Farm Manager	..	..	..	G. A. BRIDGER

Bvumbwe Tung and Agricultural Experiment Station, Box 48, Limbe

Agricultural Officer	..	..	..	L. J. FOSTER
Agricultural Chemist	..	..	..	C. V. CUTTING
Laboratory Technician	..	..	..	R. C. PEAK
Farm Manager	..	..	..	E. FABIAN

Tuchila Experiment Station, Box 28, Luchenza

Officer In-Charge	..	..	..	G. S. BARKER
-------------------	----	----	----	--------------

Makanga Experiment Station, Chiromo

Cotton Specialist (E.C.G.C.)	..	..	..	J. M. MUNRO
Farm Manager	..	..	..	D. F. COLLINGS

Mwera Hill Experiment Station, Dowa

Officer In-Charge	..	..	..	I. K. MSISKA
-------------------	----	----	----	--------------

Lisasadzi Experiment Station, Box 22, Kasungu

Officer In-Charge	..	..	..	R. F. CUMPSTON
-------------------	----	----	----	----------------

Mbawa Experiment Station, Mzimba

Officer In-Charge	..	..	..	F. HIGSON
-------------------	----	----	----	-----------

Provincial Agricultural Officers

Southern Province	..	..	..	R. SMITH
Central Province	..	..	..	H. W. T. WEBB
Northern Province	..	..	..	J. A. SANDYS

Headquarters, Zomba

Entomologist	..	..	..	Vacant
Ecologist	..	..	..	G. JACKSON
Plant Pathologist	..	..	..	D. C. M. CORBETT



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INTRODUCTION

The very wide range of environmental conditions within the comparatively small compass of Nyasaland is one of the country's chief characteristics. It makes investigational work in agriculture difficult and comparatively expensive, but essential and intensely interesting.

Generally speaking, the answers to the more important problems of agricultural practice are well ahead of their implementation by farmers, particularly African farmers. So of course they should be, but the country's progress and prosperity would be incomparably greater if the gap were not so great as it unfortunately is.

In almost all areas and with all major crops the network of experiment stations and subsidiary trial plots have now shown within accepted statistical standards when those crops should be planted, how and at what plant population; the most suitable fertilizers, how and when they should be applied and at what rate, and much else besides. Of no less importance is the growing evidence in regard to the effect of one crop on another in rotation and the value of that information in the evolution of a sound pattern of farming.

The pronounced effect of nitrogen on the yield and quality of most of the major crops and on pastures continues to be one of the most striking and important results of experimental work. There is no doubt that nitrogen will become increasingly essential to the development of the productivity of Nyasaland. But it is equally apparent that unless nitrogenous fertilizers become very much cheaper than at present that development of productivity cannot be realized, at any rate as far as the African farmer is concerned.

A great deal of useful practical information on promoting higher and more profitable yields of tea has been accumulated over the years at the research station in Mlanje District. But little attention has been paid hitherto at the Station to quality. As far as the cultural side of tea production, as distinct from manufacture, is concerned, fermentability is believed to be the most important factor. It is known to be a particularly complex subject, in which copper metabolism plays an important role. A preliminary investigation of the problem of fermentability in local teas has started, but a biochemist is badly needed to make a full study of it. Successful solution would be of the greatest importance to the tea industry.

But cotton is the crop in most urgent need of help from agricultural research. It is beset by pests and diseases to such an extent that it is becoming uneconomic to farmers, even in the most favourable environment but the matter is in hand. A team of entomologists has been formed to study the Cotton Stainer (*Dysdercus* Spp.), and the Red Bollworm (*Diparopsis Castanea*) both in Nyasaland and in Southern Rhodesia, and there is every hope that cotton varieties resistant to Bacterial Blight will very soon be available for general use. The great assistance of the Empire Cotton Growing Corporation in this, and in many other aspects of cotton investigation and research, is very gratefully acknowledged.

The willing assistance of the Tobacco Research Board of Rhodesia and Nyasaland is also much appreciated. Not only has the Board sent senior research personnel on advisory visits to Nyasaland flue-cured tobacco farmers, but it has also given courses of instruction to several extension officers of the territorial Department of Agriculture.

Acknowledgments for help in local research work are due not only to the scientists, but also to the British taxpayer. All the capital and half the recurrent expenditure have been provided from the Colonial Development and Welfare Fund for the main research station at Chitedze, whence most of the valuable information of benefit to the African farmer has come in recent years.

MAIZE

Breeding Work

1. INBREEDING

Inbreeding of the established families of inbred lines was continued and was as always the focal point of the maize breeding programme.

By virtue of the rigorous selection which has now taken place over five, six and seven generations, the lines now surviving all show in varying degrees the desirable characters for which they have been selected. These characters are: ability to combine with other lines to give vigorous hybrids, white flint or semi-flint grain, husks which cover the cob completely and prevent weevils reaching the grain, resistance to *Helminthosporium turcicum* leaf blight, resistance to lodging by the possession of a good root system, stout but flexible stems and cobs set fairly low down on the stem.

The problem is now to combine these lines into the most suitable form for distribution to African growers.

Four of the best lines were sent to South Africa where they will be used in combination with the best lines produced by all the maize breeding stations in South Africa, Rhodesia and Angola.

2. MAIZE COLLECTION

The 1,600 strains collected from the whole Protectorate in 1954 were again grown and their characters studied. A small number of outstanding strains were selected for inclusion into the main breeding stock.

3. TEST TOP CROSSES

The Top crosses made in 1954/55 between inbreds and Namlenga were tested in a yield trial. The results were most satisfactory in that they agreed with those of previous years and confirmed a number of inbreds as being of good combining ability. The highest yielding cross gave the equivalent of 5,508 lb./grain per acre and the lowest 1,147 lb.

A further series of top crosses were made for testing in 1956/57.

4. SINGLE CROSS HYBRIDS

A yield trial with 175 treatments consisted mainly of Single Cross hybrids first made in 1954/55 but also included a number of the best of the 1953/54 series to be retested, and a number of controls. The highest yielding cross gave the equivalent of 6,052 lb./grain per acre and the lowest 2,862 lb. Crosses between local inbreds and inbreds supplied by the Rockefeller Institute in Mexico yielded particularly well and had the cob characteristics which we require. Some combinations of local inbreds alone were equally good. Crosses between local inbreds and inbreds of U.S.A. origin received via South Africa did not in general yield well although in some crosses the quality of the cobs was acceptable. Crosses between local inbreds and the Southern Rhodesian inbred N-2-6-5-6 were also disappointing in yield.

A local inbred in S1 generation combined well with other local inbreds.

A further series of single hybrids were made, particular attention being paid to the field appearance of the component inbreds.

5. VARIETY TRIALS

Variety trials were conducted at Chitedze, Mbawa, Tuchila, Chitala and Makanga. At Makanga the crop was destroyed by floods and no results are available, those from other stations too were made so variable by the depredations of Army Worm caterpillars and the vagaries of the weather that it is not possible to differentiate precisely between all varieties. At Chitedze the varieties were entered in a duplicate trial of smaller size but more intensive management which gave more precise results. The high yields given from the small plots of this experiment do not correspond to those which would be expected from the same varieties grown on a large scale.

The Southern Rhodesian Hybrids and our own Top Cross 26 are the only varieties appearing in the top yielding group in all trials in which they were entered.

Top Cross 26 is a cross between Namlenga and a local inbred, this latter is particularly vigorous for an inbred and the cross is easy to make. It would, however, not be suitable for African peasants as its F_2 yield would be expected to drop considerably, also although the tip of the cob is well covered by the husks, the grain is more of a dent than local preference demands. If its performance is repeated in 1956/57 it may be of use to estates and other large growers of maize.

The local hybrid, No. 2, which did not differ significantly from Top Cross 26 in yield has dimpled flint grain of the desired type with long strong husks and has more prospect of general use.

In the meantime, Namlenga remains with the top yielders at all stations.

TABLE I

Maize Variety Trial

Yield of grain (lb./acre)

			<i>Chitedze</i>	<i>Mbawa</i>	<i>Tuchila</i>	<i>Chitala</i>	<i>Small trial Chitedze</i>
Synthetic No. 1	..	..	3,385*	2,350	3,767*	2,465	7,103
„ No. 2	..	..	4,156*	2,030	3,754*	2,077	6,368
„ No. 3	..	..	3,649	1,860	3,348	2,198	6,960
„ No. 4	..	..	3,874	1,378	2,977	2,157	5,730
Namlenga	..	..	4,214*	2,040	3,848*	2,854*	6,480
Makanga Selection	..	..	3,926	1,674	3,770*	2,505	6,255
Local Unselected	..	..	3,542	1,545	3,932*	2,211	5,663
Top Cross 26	..	..	4,587*	1,408	4,049*	3,015*	8,378*
Top Cross 28	..	..	4,144*	2,335	3,763*	2,412	7,680
Double Top Cross 26 × 28	..	..	4,245*	1,846	3,324	2,559	6,923
Double Top Cross 26 × 48	..	..	4,391*	—	—	—	—
Double Top Cross 28 × 48	..	..	3,918	—	—	—	—
S. Rhodesian Hybrid ex N.F.C.	..	..	4,213*	—	—	—	9,173*
S. Rhodesian Hybrid (N3A5) (K4T4)	..	..	4,502*	—	—	—	9,120*
Chitala selection	..	..	2,525	—	—	2,505	3,412
Local Hybrid No. 1	..	..	3,794	—	—	—	6,255
Local Hybrid No. 2	..	..	4,565*	—	—	—	7,725
Least significant difference (P=0.05)			616	no sig diff.	391	388	1,080
Mean yield	..	..	3,864	1,786	3,540	2,450	6,128
Coeff. of variation	..	..	15.6%	28.3%	9.5%	14.0%	9.4

*Highest yielding varieties not differing significantly from one another.

TABLE II
Maize Variety Trial

	Per cent. plants lodged	Aver No. cobs/ plant	Per cent. cobs with bad tip coverage	Av. scores <i>H. Turcicum</i>	Per cent. plants <i>Puccinia polysora</i>	Ratio wt. grain dry wt. stover
	Chitedze	Chitedze	Chitedze	Chitedze	Tuchila	Chitedze
Synthetic No. 1 ..	34	0.9	0	1.9	4.5	0.51
Synthetic No. 2 ..	27	1.0	0	1.8	1.9	0.67
Synthetic No. 3 ..	37	1.0	0	1.7	3.8	0.53
Synthetic No. 4 ..	40	1.0	0	2.0	1.9	0.54
Namlenga ..	34	1.1	0	1.6	5.1	0.97
Makanga selection ..	41	1.2	5	2.1	6.4	1.53
Local Unselected ..	27	0.9	0	1.8	9.6	0.51
Top Cross 26 ..	41	1.1	3	1.8	12.8	0.64
Top Cross 28 ..	32	0.9	3	1.7	3.2	0.55
Double Top Cross 26 × 28	32	1.0	0	1.6	2.6	0.54
Double Top Cross 26 × 48	29	1.0	36	1.6	—	0.64
Double Top Cross 28 × 48	39	1.0	25	1.9	—	1.03
S. Rhodesian Hybrid ex N.F.C. ..	34	1.1	75	1.6	—	0.75
S. Rhodesian Hybrid (N3A5) (K4T4) ..	36	1.0	15	1.5	—	0.76
Chitala Selection ..	46	1.1	0	1.7	—	0.78
Local Hybrid (15 × 3) (10 × 1)	35	0.9	15	2.2	—	0.52
Local Hybrid (20 × 19) (8 × 9)	48	1.0	0	1.5	—	0.72
S. Rhodesian Hybrid No. 7	—	—	—	—	45.5	—

6. DISEASES

(a) Rusts

The common rust *Puccinia sorghi* was widespread but no varieties were particularly susceptible and the incidence of this disease was as usual mild. Breeding for resistance to *Puccinia polysora* continued with the growing of 254 strains at Chitedze, Balaka and Makanga both of which latter stations are known to experience severe attacks of the disease. The strains were mostly seed from cobs harvested from disease-free plants in 1954/55 of E.A.A.F.R.O. resisters and crosses with them and local material. At Makanga, the maize was destroyed by floods but at Balaka, in the midst of a general attack, the lines again showed segregation and a number of plants remained disease free. Cobs from these plants were harvested and the best are being used in further work. At Chitedze a slight attack developed late in the season but did not allow for any selection between lines.

At Chitedze a yield trial was conducted of 17 crosses between Makanga selection and E.A.A.F.R.O. resistant lines. The trial was late planted but the top yielding cross gave the equivalent of 3,692 lb./grain per acre. The top yielding crosses are being tested again.

(b) Leaf Blight

Leaf Blight caused by the fungus *Helminthosporium turcicum* was the most important disease of maize, especially in the main maize-growing areas. At Chitedze, the inbred lines were artificially infected with a spore culture and with diseased leaf material from the previous year, this resulted in a severe attack which enabled resistant and susceptible lines to be distinguished. Elsewhere on the station the attack was not so severe. 217 established inbred lines were scored on the scale 0.5 to 5.0 (*vide Phytopathology*, Vol. 36, 1946) as under:—

Score	Number of lines
0.5 very resistant ..	12
1 to 1.5 moderately resistant ..	107
2 to 3 moderately susceptible ..	74
4 to 5 very susceptible ..	24

As in the previous two seasons an experiment was conducted to compare the yields of plots open to natural infection with those protected by regular spraying with ZINEB (a preparation of zine ethylene dithiocarbamate). This season the spraying was done twice weekly from when the plants were six weeks old until maturity. The spray was applied at the rate of 2 lb. in 200 gallons of water per acre. In dry weather the unprotected plots were sprayed with plain water, whenever fungicide was applied to the protected plots. The natural infection on this experiment this season was light but, nevertheless, there was an overall decrease in yield of 11 per cent. on the unprotected plots as compared with the protected ones. This figure was 6 per cent. in 1953/54 and 14 per cent. in 1954/55. Scores are given for the incidence of leaf blight and the two rusts on this experiment but the damage caused by each of them is uncertain.

It will be seen that the loss of yield suffered does not correspond with the difference in scores for disease. There is a statistically significant interaction between spraying and the yield of different varieties, whilst the disease scores are of the same order. This effect was observed also in the 1953/54 experiment and may be an expression of the tolerance of the more variable open pollinated varieties to the presence of disease as compared with the two hybrids.

TABLE III

Trial to Assess the effect of Fungus Diseases on Yield of Maize

Average scores per plant (Scale 0.5 to 5.0) 14/4/56

				Local un- selected	Namlenga	S.R. Hy No 7	Local Hy 20 × 17	All
Sprayed	..	..	..	0.47	0.43	0.32	0.34	} <i>H. turcicum</i>
Unsprayed	..	..	..	1.20	1.33	1.10	0.93	
Sprayed	..	..	..	0.03	0.08	0.00	0.06	} <i>P. sorghi</i>
Unsprayed	..	..	..	0.54	0.65	1.10	0.59	
Sprayed	..	..	..	0.00	0.00	0.00	0.01	} <i>P. polysora</i>
Unsprayed	..	..	..	0.21	0.08	0.01	0.09	

Yield of grain (lb. per acre)

Sprayed	..	..	..	5,745	5,970	5,902	7,515	6,302
Unsprayed	..	..	..	6,255	5,678	4,328	6,150	5,603
per cent. decrease			..	+9	6	27*	18*	11*

L.S.D. (P = 0.05) — 699 — — — 324

*=statistically significant.

An experiment was carried out to assess the effect of maize stover used as a mulch, especially in relation to the incidence of maize diseases. Three varieties of maize were grown on plots, four of which were mulched with maize stover from the previous season and four were mulched with bush grass. The plots were separated by 30 rows planted with bulrush millet, sorghum and maize to try to prevent the spread of disease between them.

TABLE IV

Trial to Assess the effect of Maize Stover Used as a Mulch on a Following Maize Crop

Average scores per plant (scale 0.5 to 5.0)

				Helminthosporium turcicum		Puccinia sorghii	
				grass mulch	maize mulch	grass mulch	maize mulch
S.R. Hybrid No. 7	..	..	..	1.69	2.51	1.48	1.35
Namlenga	..	..	..	1.83	3.16	1.10	1.26
Chitala selection	..	..	..	1.75	3.44	1.28	1.23
All varieties	..	..	..	1.76	3.04	1.27	1.28

Yield in lb. grain/acre

				Grass mulch	Maize mulch	Decrease
S.R. Hybrid No. 7	..	..	..	3,139	2,594	17%
Namlenga	..	..	..	3,588	2,659	26%
Chitala selection	..	..	..	1,944	1,658	15%
All varieties	..	..	..	2,890	2,302	20%

This experiment occupied so much land that it was only possible to have four replications and this was insufficient for the considerable differences which have occurred to be demonstrated statistically. It is seen, however, that the incidence of *Helminthosporium turcicum* was considerably greater on the plots mulched with maize stover, this being caused by the greater local concentration of spores released from diseased tissue of the previous season. *Puccinia sorghi* does not show the same effect. The loss in yield of the maize-mulched plots as compared with the grass-mulched must certainly be due at least in part to the differences in disease between the two treatments, although there may be effects attributable to the mulches as such. This experiment and the spraying experiment, described above, do show, however, that appreciable loss in yield from the maize crop is suffered annually from fungus diseases, particularly *Helminthosporium turcicum*, hence the need for resistant varieties. The data in this Report and that published in the Report for 1954/55 also shows that the severity of the disease can vary greatly between adjacent localities and is influenced by field husbandry practices.

Fertilizer Trials

RESIDUAL EFFECTS

Phosphate. Last year, at Chitedze, superphosphate applied at 300, 600 and 900 lb. per acre all gave significant increases. There were no significant residual effects, though the highest rate of application gave an increased yield of 300 lb. maize per acre which was nearly significant.

Organic manures. Last year experiments showed marked responses to the application of both farmyard manure and *khole* manure, the latter giving the higher increases. Phosphate gave a response at Mbawa only, band application gave insignificant increases over dollops and there was no difference for the time of application. The residual effects are given in the table below.

TABLE V

Residual Responses of Maize to Farmyard and Khola Manure and Superphosphate

Treatment	Chitedze		Tuchila		Mbawa	
	Yield/acre	response	Yield/acre	response	Yield/acre	response
Nil	3,884	—	949	—	542	—
5 ton/acre F.Y.M.	4,023	139	1,068*	119*	670*	128*
Nil	3,729	—	850	—	570	—
5 ton/acre KH.M.	4,179*	450*	1,167***	317***	643*	73*
Nil	3,859	—	971	—	614	—
100 lb/acre Super	4,049	—	1,046	—	598	—
Applied 1 week before planting	4,047	—	1,029	—	574	—
Applied 5 weeks before planting	4,066	—	988	—	637	—
Applied in band	4,155	—	1,138***	259***	589	—
Applied in dollop	3,958	—	879	—	623	—
L.S.D. (P=0.05)						
Manures	—	310	—	88	—	71
Method application	—	427	—	102	—	82
Coef. of variation	—	12.4%	—	11.6%	—	15.5%

The residual value of both farmyard and *khola* manure is clearly shown and is more marked with an equal weight of *khola* manure than with farmyard manure. The amount of the response is variable and has been greatest at Tuchila where one application of 4 tons of *khola* manure has given an increase of 850 lb. of maize in the two years of the experiment.

COMPARISON OF ARTIFICIAL FERTILIZER AND ORGANIC MANURES

Two trials, in one of which phosphate replaced *khola* manure, were carried out and gave the results in the table below.

TABLE VI

Response of Maize to Artificial Fertilizer and Organic Manures

Treatment	(Yields in lb. grain per acre)			
	Chitedze		Tuchila	
Farmyard manure				
Nil	..	3,393	..	2,022
5 tons/acre	..	3,977	..	2,234
10 tons/acre	..	4,097	..	2,818
Khola manure				
Nil	..	3,186	..	—
5 tons/acre	..	4,004	..	—
10 tons/acre	..	4,277	..	—
Sulphate of ammonia				
Nil	..	3,365	..	1,743
100 lb/acre	..	3,923	..	2,322
200 lb/acre	..	4,179	..	3,008
Superphosphate				
Nil	..	—	..	2,449
200 lb/acre	..	—	..	2,224
400 lb/acre	..	—	..	2,400
L.S.D. 5 per cent.	..	281	..	299
Coef. of variation	..	10.8%	..	18.6%

From this it will be seen that 100 lb. of sulphate of ammonia gives a response which may be equal to 5 or 10 tons of organic manure depending on the conditions. If the residual effect of the farmyard manure is considered then 5 tons of manure is worth more than 100 lb. of sulphate of ammonia.

Cultivation trials

Various cultivation trials are in progress but as it is necessary to carry on these experiments for several years the details are not reported now. In the preparation of gardens, burning the stover and leaving the ash on the plots has given the highest yields, but as burying trash leads to a competition for nitrogen the depressing effect of this treatment in the first year may be offset by a gradual accumulation of humus during the rotation.

An experiment on various methods of opening resting land gave the following results.

TABLE VII
Yields of Maize after Four years' rest under Bush Fallow

<i>Treatment</i>	<i>Grain yield lb./acre</i>
Dig in February and plant cowpeas	3,550
Dig in March and bury grass	3,275
Dig in February and plant sweet potatoes	2,985
Dig in October after burning grass	2,033
Burn in June and dig after first rains	1,888

This experiment clearly shows the great importance of early clearing when resting land is brought back into cultivation. Late clearing just about halves the yield that is possible when the land is opened at the right time. The planting of a quick-maturing legume is permissible but sweet potatoes should not be used for this purpose. There was no crop of consequence from either the cowpeas or sweet potatoes when late planted in this way.

SORGHUMS

A limited number of varieties from the collection were planted at Chitedze and Tuchila. Yields were generally poor at the former, while at Tuchila, the varieties imported from the Sudan gave much higher yields than the local types, the reverse of results in previous years. Somewhat surprisingly at neither station did 100 lb. of sulphate of ammonia give any increase in yield.

The yields of the leading varieties are given below.

TABLE VIII
Yield of Sorghum in lb. grain per acre

	<i>Chitedze</i>	<i>Tuchila</i>	<i>Mbawa</i>
S/S 40	932	1,790	399
S/S 28	829	1,770	1,337
S/S 25	508	1,627	1,368
S/S 10	218	1,593	—
U/S 2	1,010	839	—
T/S 26	877	839	—
U/S 16	629	430	2,006
N/S 10	847	42	835

CEREALS

Oats have given higher yields at Bvumbwe than ever obtained from wheat. Over the past three years the following yields have been obtained on plots up to an acre in size:—

Variety					Year	Yield grain (lb. per acre)
Huskless	..	..	..	..	{ 1954 ..	955
					{ 1955 ..	627
					{ 1956 ..	983
S 15	..	..	..	..	{ 1955 ..	440
					{ 1956 ..	782
Time of sowing: last week in February to first in March.						
,, ,, harvesting: July to August.						
Seed rate—175 lb. per acre.						

It has a use as a stock feed or for haymaking, especially if mixed with hairy vetch. *Vicia villosa*, an annual legume which does extremely well at Bvumbwe. Oats or the mixture also makes a useful green cover crop in orchards.

OIL SEEDS

Groundnuts

VARIETY TRIALS

A collection of some 140 varieties is maintained at Chitedze and during the past year yield trials have been carried out at various stations using a limited number of varieties that have been selected visually. The results have shown that at elevations below about 2,500 feet above sea level the early bunch types, typified by Gambia and Spanish Bunch, have consistently given the best yields. At higher elevations the results have not been so consistent, sometimes the early bunch giving best yields and sometimes later maturing types. In the Lilongwe area, Mwitunde, besides yielding well, has other desirable qualities such as dormancy and a certain tolerance or partial resistance to diseases. This variety is now being bulked up for distribution.

At Chitedze a very large trial, with 125 varieties was successfully carried out and some which had not previously been put into trials yielded well. The top five places (with yields ranging from 1,260 to 1,520 lb. shelled nuts per acre) were late runners and these were followed by nine early bunch varieties including the Gambia which is now taken as a standard variety of this type. At Tuchila all the top places were taken by early bunch types and the late runners yielded very much less. At Mbawa the local late runner type gave the best yield, early bunch types yielding considerably less. At Chitala the early bunch gave the best results with Gambia and Barberton both yielding at the exceptionally high rate of over 3,000 lb. shelled nuts per acre while Mwitunde was only a little over 1,100 lb. per acre. These results are all quite consistent with previous experience.

CERCOSPORA CONTROL EXPERIMENT

The spraying trial this year included a treatment of spraying the soil with copper sulphate to test if the increased yields found from spraying with Perenox could be attributed to a copper deficiency and the results are given in the table below.

TABLE I
Effect of spraying to control Cercospora Spot
(Variety Mwitunde. Yields in lb./acre shelled nuts)

<i>Treatment</i>					<i>Yield</i>
Spray with Perenox once or twice a week	..	..	..	..	1,693
Spray with Perenox every 3 weeks	..	..	..	..	1,206
No spray	..	..	..	..	1,075
Spray soil with copper sulphate every 3 weeks				..	1,027
L.S.D. P=0.05 71 lb. per acre.					

There was very little difference between treatments in a count of leaflets attacked but visual differences were large. The sprayed treatments had a few large lesions while the unsprayed had a dense crop of small spots on the leaflets. The sprayed treatments remained greener for much longer than the unsprayed.

Soya Beans

VARIETY TRIALS

Early maturing varieties yield very poorly in Nyasaland usually giving less than 100 lb. per acre seed. Medium and late types yield well and early varieties have been discarded.

TABLE II
Yield of Soya Beans Varieties in lb. per acre

<i>Variety</i>					<i>Chitedze</i>	<i>Yield</i> <i>Tuchila</i>	<i>Mbawa</i>
Potchefstroom	..	..	..	..	917	1,237	949
Pelican	..	..	..	..	890	976	605
S-100	..	..	..	..	882	1,088	208
Hernon 279	..	..	..	..	862	1,120	845
Hernon local	..	..	..	..	849	875	807
Light speckled	..	..	..	..	844	747	525
Ogden	..	..	..	..	832	855	633
Benares	..	..	..	..	738	907	877
Malaya	..	..	..	..	683	1,196	970
L.S.D. P=0.05	..	..	..	..	96	N/S	N/S

TABLE III
Variety Trial at Bvumbwe

<i>Variety</i>					<i>Yields in lb. clean seed per acre</i>	<i>Yield</i>
S-100	..	..	..	..	..	2,118
Local Yellow	..	..	..	..	..	1,976
Peruvian Yellow	..	..	..	..	..	1,959
Hernon 279	..	..	..	..	..	1,876
Volstate	..	..	..	..	..	1,613
Pelican	..	..	..	..	..	1,371

CULTIVATION TRIAL

Trials were carried out at three stations, testing times of planting, spacing and the application of phosphate. The first time of planting varied between 3rd and 8th December, the second from 16th to 20th December and the last from 3rd to 14th January. As with so many crops the early planting gave much the best yield. The crop was planted on ridges three feet apart and 1, 2 and 3 rows were planted on the ridge and with a spacing of 3-4 inches between plants. The final stand was generally about 60 per cent. but in the single row plots at Chitedze it was only 33 per cent. which may account for part of the lower yield in this treatment. If 3 feet ridges are used then two rows on each ridge are all that need be planted provided a full stand can be ensured. Phosphate has not given significant increases in yield but there is a slight trend towards higher yields especially at Mbawa.

TABLE IV
Cultivation trial on Soya Beans
Yields in lb. seed per acre

					Time of Planting		
					<i>Chitedze</i>	<i>Tuchila</i>	<i>Mbawa</i>
Early December	..	..	..	..	1,800***	..	1,003***
Middle December	..	..	..	..	1,428**	..	729
Early January	..	..	..	..	1,207	..	Nil
L.S.D. P=0.05	..	..	..	..	191	..	173
					No. of rows per 3 ft. ridge		
One	..	..	..	..	1,273	..	781
Two	..	..	..	..	1,512***	..	812
Three	..	..	..	..	1,651***	..	1,005
					Superphosphate		
Nil	..	..	..	..	1,422	..	839
100 lb. per acre	..	..	..	..	1,463	..	876
200 lb. per acre	..	..	..	..	1,581	..	884

Sunflower

Although yields at Bvumbwe have been fairly good, the quality of the seed from trials over the last two years has been poor. Losses from birds have to be guarded against and the drying of seed has proved difficult.

TABLE V
Yields of dry seed (lb. per acre)

<i>Variety</i>					<i>Year</i>	
					1956	1955
American White	..	..	..	..	1,851	..
Kampala White (ex Chitedze)	..	..	..	..	1,621	..
American Striped	..	..	..	..	1,386	..
American Black	..	..	..	..	1,209	..
Giant Black (ex Chitedze)	..	..	..	..	901	..
L.S.D. P=0.01	..	..	..	..	332	..
Planting distances	..	..	..	..	3' x 3'	..
					3 plants per stand	..
Time of sowing	..	..	..	..	29th November	..
„ „ harvesting	..	..	..	..	21st March	..

Yields from sowings made at the end of December and January were or would have been much lower (the 1956 late sowings were ruined by a cyclone). The emphasis seems to be on early planting.

Applications of 100 lb. and 200 lb. per acre of sulphate of ammonia 10 days after sowing produced slight increases of yield which were not significant.

TUNG

1. Production of Improved Planting Material

1. 1. BUDDINGS VERSUS SEEDLINGS

The experiments, described in last year's Report, continue and there are no new developments to report at this state. It is intended to publish elsewhere a detailed

account of the planting material that is available as the result of recent experiments. In the "classical" experiment buddings of selected clones on *montana* rootstocks continue to be superior to all other methods of propagation.

TABLE I
Buddings versus seedlings, 1956
(Yield in lb. air dry seed per tree)

Treatment	CLONES				
	M8	M13	H14	F9	Mean
Montana stock	43.7	49.4	48.6	34.6	44.1
Fordii stock	35.7	34.3	55.2	37.2	40.6
Selected seedlings	40.3	17.9	16.5	22.8	24.4
Unselected seedlings	—	—	—	—	16.1
Mean	39.9	33.9	40.1	31.5	—
Yield per acre (short tons)	2,234	1,898	2,246	1,764	—

L.S.D. for treatment means .. P=0.01 = 16.9
P=0.05 = 12.2
,, ,, clone means .. P=0.05 = 8.31

The trial of *fordii* seedlings and buddings show that none have yet attained the growth, as measured by girth, of the budded *montana* clone 10 on *montana* rootstock: clone 10 is already yielding a small crop.

TABLE II

Treatment				Mean girth (cm.)
Montana clone 10 on <i>montana</i> rootstock	..	..	..	35.4
Local <i>fordii</i> seedlings NZ101	..	..	..	27.4
U.S.A. <i>fordii</i> seedling Lampton F578	..	..	..	25.6
F578 on <i>montana</i> rootstock	..	..	..	23.6
<i>Fordii</i> seedlings ex Swaziland	..	..	..	23.6
U.S.A. <i>fordii</i> seedling, L152	..	..	..	21.6
,, ,, ,, Gahl	..	..	..	20.8
,, ,, ,, Isabel L2	..	..	..	20.4
L2 (Isabel) on <i>montana</i> rootstock	..	..	..	20.2
U.S.A. <i>fordii</i> seedling Lampton F578	..	..	..	17.2
Local <i>fordii</i> seedling NZ5	..	..	..	17.2
L2 (Isabel) on <i>fordii</i> rootstock	..	..	..	14.4
L.S.D. P=0.05	..	..	..	2.8
P=0.01	..	..	..	3.7

1. 2. CLONAL TRIALS

Clone 10 is one of the best vigorous B types. 16-year old trees gave the following yields:

TABLE III
Clonal trial at Bvumbwe
(lb. air dry seed)

Clone	10	N24	14	F9	M8	L.S.D. P=0.01
Mean yield per tree	46.8	46.0	36.2	32.3	28.9	9.18
Yield per acre	2,620	2,576	2,027	1,809	1,618	514

2. Cultural Practices

The new intercropping experiment on the Vipya has had to be abandoned. That at Bvumbwe has shown that it is unwise to attempt to impose the labour-

saving treatments until the trees have been established. That is, the trees should be clean cultivated for the first three years. The same applies to the spacing trial.

3. Fertilizer trials

3.1. N.P.K.

The sixteen year old experiment at Bvumbwe still shows a response only to nitrogen. 3 lb. of sulphate of ammonia per tree produced an increase of 218 lb./dry seed per acre.

3.2. N.P.K. WITH COPPER AND ZINC

The experiment at Bvumbwe still shows no clearcut response to any treatment, although this is the fifth crop produced. The experiment is on a good site and a mean yield of 1,893 lb. of dry seed per acre was produced. Another experiment, in a drier climatic area near Zomba, showed a significant response to nitrogen (3 lb. S/A per tree) but to no other treatment; this field, with trees about the same age as at Bvumbwe, produced a mean yield of 955 lb./acre.

3.3. N.P.K. WITH DUNG

Dung and sulphate of ammonia have given consistently increased yields on an experiment near Zomba.

TABLE IV
NPK with Dung Trial (Gala)
Yield in lb. dry seed per acre)

<i>Experimental mean</i>	<i>Treatment effect over mean</i>		<i>L.S.D. P=0.01</i>
	<i>N</i>	<i>D</i>	
722.3	381.8	170.5	130.6

N=3 lb. sulphate of ammonia per tree (237 lb./acre).
D=100 lb. dung per tree (4 tons/acre).

3.4. NITROGEN

As nitrogen is the one element which appears to be capable of producing a consistent increase in the yield, its effect is being compared when applied as sulphate of ammonia or tung cake. Different times of application are also being compared since it fits in with the routine of some estates to apply well before the rains.

TABLE V
Nitrogen Fertilizer trials on young trees
(Yield in lb. air dry seed per tree)

<i>Treatment</i>				<i>Control</i>		<i>Tung cake lb./tree</i>		<i>Sulphate of ammonia lb./tree</i>					<i>L.S.D. P=0.05</i>
				0	20	30	2	4	4*	6	6*		
Gala				4.7	3.9	4.8	5.5	6.7	8.9	5.6	5.3		2.8
Nchima				2.2	3.1	3.0	4.7	5.8	5.7	4.5	3.4		2.5

*These two applications were made as follows:
Gala—split applications in October and December.
Nchima—4 lb. applied in July.
6 lb. applied as split applications in July and October.

3.5. FERTILIZER EXPERIMENT, MZUZU

This experiment was started in 1948 when budded stumps of clone 0-4 were planted out. The results for the last year are given in the table below.

TABLE VI
Effect of Nitrogen and Phosphate on Tung
Yields in lb. fruit per acre

Effect of nitrogen			Effect of phosphate		
lb. sulph. amm/tree		lb. fruit per acre	lb. supers per tree		lb. fruit per acre
nil	..	467	nil	..	795
1	..	854	—	..	822
2	..	779	—	..	693
3	..	929	—	..	714

The only significant effect is that of nitrogen and there is no difference between the different levels. This is somewhat surprising in view of the age of the trees but this result has been consistent over the past three years. 1 lb. of sulphate of ammonia per tree has almost doubled the yield but there is no further increase. The trees have not yet reached their maximum yield. There was no effect from either phosphate or potash.

4. Other Tung Experiments

4.1. BIENNIAL BEARING

Pressure of other work has prevented further study of this problem. The 1956 yields of three plots described in the 1955 Report did not reflect the treatments given to them during June to August, 1955.

TABLE VII
Yield per tree (lb. dry seed)

Treatment				six year mean	Yield	
					1955	1956
Covered to exclude rain	..	..	..	27	48	90
Irrigated	..	..	..	41	44	62
Natural rain	..	..	..	42	35	48

It is intended to investigate the problem further with the use of gypsum blocks.

4.2. BOTRYOSPHAERIA DIEBACK

The spraying experiments described last year were repeated. All dieback was pruned off; the trees were then sprayed and dieback counts made subsequently. There seemed to be no control of value by spraying. Pruning seems to be the most efficient and economical method of control.

4.3. ARMILLARIA MELLEA continues to be the most devastating disease on tung. It appears capable of lying dormant for some years; in a plantation planted in 1947 the first attacks did not occur until 1955.

Acknowledgements are made to Messrs. Nyasa Tea Estates, East Asiatic Coy. and Nchima Tea & Tung for facilities rendered for the conducting of experiments on their crops.

Extract from Agricultural Chemist's Report

Tung Oil

1. STATUTORY ANALYSES OF EXPORTED OIL

Sixty-one samples from 868 tons (839 tons montana and 29 tons fordii) were examined—27 of these analyses being carried out at the Department of Agriculture's Laboratories, Salisbury, during the leave of the Agricultural Chemist. The distribution of exports was 492 tons to Europe, 170 tons to U.S.A. and 206 tons to Africa.

2. TUNG OIL COMPOSITION

Although the B.S.I. have amended their specification to allow a heat test of 26 mins. for the Montana oil, the reasons for the longer gelation period of Nyasaland oil, and also for the difference between the oils from the two factories in the Cholo and Zomba area had still to be resolved. This work has continued over the past two or three years as time permitted, and a progress report may now be made. The points to examine were:—

- (i) The effects of soil nutrients on oil composition.
- (ii) The effect of a particular clone.
- (iii) The age of the trees—as the main Zomba estate was younger than the older established Cholo estates.
- (iv) Possible changes of the oil during the expelling process.
- (v) Climatic differences of the localities.

As found in America, shortage of potash has led to reduced oil content in the seed, and it might follow that higher potash supplies, causing higher oil contents, would affect oil composition. Figures for oil content and composition obtained on seed from fertilizer trials at the Tung Station are given in Table VIII, as are also corresponding results for seed from the Vipya.

TABLE VIII
Tung oil—Content and Composition

(i) *Effect of Fertiliser treatments on oil Content*
Southern Province

Clone				O	N	P	K	NK	PK	NPK
<i>A-type</i>										
M8	..	..	..	64.3	63.2	59.0	64.1	60.5	60.8	62.7
M13	..	..	..	64.5	64.2	64.1	63.5	58.6	57.8	63.6
<i>B-type</i>										
N4	..	..	..	64.0	64.0	—	59.6	—	—	65.7
O4	..	..	..	66.0	—	—	—	—	—	63.8
<i>Vipya</i>										
Mixed B-types	..	..	..	61.4	63.8	62.6	64.8	61.9	65.7	63.7
O4	..	..	..	64.1	64.3	65.2	67.6	—	—	—

(ii) *Composition of Tung oil (Southern Province)—B-elaestearic acid*

				O	N	P	K	NK	PK	NPK
M8	..	..	..	73.1	71.0	71.8	74.1	72.2	77.1	75.8
M13	..	..	..	73.2	75.2	68.6	73.7	74.9	70.0	73.5
N4	..	..	..	72.8	—	—	69.6	—	—	67.2
O4	..	..	..	70.1	—	—	—	—	—	70.4

Although these figures are the mean of four determinations on separate seed samples, it is seen that there is not a consistent effect of fertilizers on the oil content of seed from the differently fertilized plots at the Tung Station. In the Vipya, the

effect of potash is more pronounced as seen from the K, KP and NPK plots of the main experiment using the precocious B-type clones. Little increase is obtained on the NK section. Also on the O4 clone, which is also a B-type, the same effect of K is seen. This action of K, may be due to the lower potassium status of the Vipya soils, or it may be that their poor nitrogen content gives a lower yield of seed which leads to a higher concentration of oil in the seed. This latter view has some support, in so far that the B clones, which are more precocious, generally give seed of a rather lower oil content than that obtained from the A-type trees. This has been confirmed by figures obtained from Dr. Raymond, at the Colonial Products Laboratory on other samples of Vipya tung seed.

Little information is available on any effect of plant foods on content and saturation of vegetable oils. Figures for content of elaeostearic acid, as have so far been obtained, are also given in Table VIII. There does not seem to be any consistent effect of fertilizer on the composition of the oil—nor any defined relationship between oil content and elaeostearic acid content, although a higher oil content does tend to have a reducing effect on the elaeostearic acid content. It does not, therefore, seem that the higher K status of the Zomba soils would explain the lower gelation time of these oils, for samples of seed gave figures of 64–65 per cent. oil content and 64.5 per cent. for the Cholo and Zomba seed respectively in normal seasons.

Many different samples of M13 seed were taken from the main Zomba estate, and the figures for oil content and elaeostearic acid determined. As the trees on this estate were younger than the bulk of the Cholo area, it was considered that if the

elaestearic acid content of the seed was found to vary with ages of the trees, this would afford some explanation of the observations made on gelation time. Seed from M13 trees planted in 1945, 1949 and 1951 were therefore collected and the oil oil examined after solvent extraction. The results are shown below, these being the mean of 4–6 different seed selections in each instance. At the same time a special collection of seed from younger trees from an estate in the Cholo area was also made. This was predominantly M13.

TABLE IX

						Oil content	% Elaeos- tearic acid in oil
Zomba M 13	9 yrs. old	..	..	..	64.0	..	72.8
"	" 5 "	..	..	..	65.2	..	71.3
"	" 3 "	..	..	..	67.2	..	70.7
Cholo, young trees		..	..	..	61.6	..	75.8

Although there is a slight increase in elaeostearic acid and decrease in oil content as the trees get older, this does not fully explain these phenomena as the younger trees in Cholo produce oil of a higher elaeostearic acid and therefore a lower gelation time.

The fourth possibility, after considering the effect of soil, clones and age of the trees, was the fact that the two factories were using different makes of expellers, although these basically worked on the same principle, viz: steam heating of the kernel, with subsequent expression in a continuous screw press. As the times and method of cooking the seed varied, there was the possibility that some of the elaeostearic glycerides might be polymerised or precipitated with the cake. Thus the composition of the expelled oil would vary from that in the seed originally. A batch of M13 seed was therefore harvested and expressed separately—samples of the seed and resultant oil being taken periodically throughout a morning's run. The range of elaeostearic acid content in the solvent extracted oil was 72.4–73.2 per cent.,

while that of the expressed oil was 75.4—76.7 per cent. for seed from the old plantations. A corresponding experiment on seed from the 5-year old plantations gave figures of 72.5 per cent. for the expressed oil against the 71.3 per cent., as already quoted, for the solvent extracted oil from this seed. The young seed from the Cholo estate was also expressed separately and the content of elaeostearic acid found in this oil was 74.8 per cent.

The Colonial Products Laboratory have used a hand press to obtain samples of oil from various tung seed, and in most instances the content of elaeostearic acid in the expressed oil was slightly higher than in the solvent extracted oil. It appears, therefore, that the expelling process itself does not cause the anomalous behaviour of the Zomba area oil.

The remaining explanation would be that of climatic conditions. The Zomba area is only $\frac{1}{2}^{\circ}$ latitude nearer the equator than is the main Cholo Tung growing area, but it is about 500 feet lower and generally has maximum and minimum temperatures 5° higher during the months of seed developing and ripening (December–April). But in addition, although no records of sunlight are available, it is readily observed that the Cholo area is more over-cast, being close to Cholo Mountain and also being affected by the cloud accumulation from Chiperoni Mountain in Portuguese East Africa. The rainfall in the Zomba area is about 10 inches less than on the Cholo estates, and the effect of this difference has already been seen from the fact that in a very dry year the kernel content of the Zomba seed is reduced more than that of the Cholo seed. It may well be that the rather higher temperatures, and less wet and cloudy conditions of Zomba, will lead to a shorter developing and ripening period.

The content of unsaturated acids will consequently be less than that of oils obtained from seed which has developed more slowly in rather colder conditions. The effect of the expelling process is still, however, being examined to fully resolve this problem. Tests made at the Colonial Products Laboratory, suggested that as no B—elaestearic was found in the filter cake, there may be some retained in the press-cake and this aspect is being pursued.

TOBACCO

Dark Fire-Cured Tobacco

1. VARIETY TRIALS

Variety trials were carried out at Chitedze and Tuchila and the yields of the leading strains are given in the tables below. At Chitedze, imported varieties were at the top of the table but the yields were not significantly higher than some of the local Western selections. At Tuchila, exceptionally high yields were recorded and local strains gave the highest yields but were not significantly better than American types. These results are consistent with previous reports that Nyasaland strains, when grown in America, do not differ greatly from the best of the American selections.

TABLE I

Variety Trials—Dark Tobacco

(a) *A.R.S. Chitedze* (Varieties tested—25)

Variety	Yield lb./acre	Grade Index	Crop Index
Type 5	839 ..	68.48 ..	57,455
Brownleaf	761 ..	70.27 ..	53,475
Greenwood	759 ..	69.72 ..	52,917
Harrow Strain 52204 ..	684 ..	72.60 ..	49,658
T 9/A/A	792 ..	57.95 ..	45,896
Little Crittenden ..	634 ..	67.63 ..	42,877
Madole	752 ..	54.84 ..	41,240
Western (Namitete) ..	633 ..	65.13 ..	41,227
L 44/C/C	662 ..	60.95 ..	40,349
C 1/14	563 ..	69.49 ..	39,123
Western (Tuchila) ..	618 ..	61.78 ..	38,180
C 3/42/A/D	533 ..	67.34 ..	37,239
L.S.D. ($P = 0.05$) ..	202 ..	12.5 ..	—

(b) *Tuchila Experimental Station* (Varieties tested—12)

C 3/42/A/D	1,703 ..	52.80 ..	89,918
Western (Tuchila) ..	1,649 ..	51.50 ..	85,593
Little Crittenden ..	1,662 ..	51.06 ..	84,198
Western (Namitete) ..	1,595 ..	52.20 ..	83,259
Brownleaf	1,523 ..	53.61 ..	81,648
Harrow Strain 52204 ..	1,576 ..	50.59 ..	79,730
L.S.D. ($P = 0.05$) ..	146 ..	8.71 ..	—

2. FERTILIZER TRIALS

(i) *Responses to Nitrogen and Phosphate*

This season co-operation was sought from neighbouring estate-owners in an attempt to determine the reactions of as many soil types as possible to additions of nitrogenous and phosphatic fertilizers. Only one experiment could be analysed statistically—the others failing to reach this stage through various causes.

TABLE II

Fertilizer Trial—Namitete Estate

(a) *Nitrogen*

	Sulphate of Ammonia (lb. per acre)			<i>L.S.D.</i> ($P = 0.05$)	<i>L.S.D.</i> ($P = 0.10$)
	0	100	200		
Yield (lb./acre) ..	411 ..	644 ..	733 ..	93.4 ..	136.0 ..
Grade Index ..	29.16 ..	39.41 ..	41.15 ..	7.09 ..	10.30 ..
Crop Index ..	11,982 ..	25,392 ..	30,171 ..	.. ..	— ..

(b) *Phosphate*

	Superphosphates. (lb. per acre)			<i>L.S.D.</i> ($P = 0.05$)
	0	200	400	
Yield (lb./acre) ..	590 ..	617 ..	581 ..	.. ..
Grade Index ..	36.4 ..	38.66 ..	34.67 ..	.. ..
Crop Index ..	21,480 ..	23,869 ..	20,140 ..	.. ..

3. CULTURAL TRIALS

The results from this experiment confirmed those from previous years. Early planting, at the beginning of December, not only gave increased yields but also gave much higher grade indexes, largely through a much higher percentage of long leaf. The plants were rather small so the number of leaves that could be left were smaller than is possible of well-grown tobacco and the higher numbers gave greater yields. Nitrogen once again gave a significant increase but there were no significant interactions.

TABLE III

Effect of Time of Planting, Number of Leaves and Nitrogen on Dark Tobacco

(a) Time of Planting							
Planting Dates							
		9-12-55	24-12-55		5-1-56	L.S.D. ($P=0.05$)	
Yield (lb./acre)	..	546	..	419	..	462	.. 95.0
Grade Index	..	44.80	..	16.46	..	19.66	.. 3.79
Crop Index	..	24,282	..	6,907	..	9,083	.. —

(b) Number of Leaves							
		5.8	7.5		7.9	L.S.D. ($P=0.05$)	
Yield (lb./acre)	..	412	..	491	..	524	.. 95.0
Grade Index	..	23.57	..	28.14	..	28.90	.. 3.79
Crop Index	..	9,723	..	13,822	..	15,135	.. —

(c) Nitrogen							
Sulphate of Ammonia (lb. per acre)							
		0	50		100	L.S.D. ($P=0.05$)	
Yield (lbs./acre)	..	409	..	486	..	531	.. 95.0
Grade Index	..	25.23	..	26.85	..	28.53	.. 3.79
Crop Index	..	10,339	..	13,054	..	15,161	.. —

A somewhat similar trial at Tuchila combined the effects of different levels of priming before harvest and leaving more than the normal number of leaves. Full priming, the normal practice, gave the highest grade index but reduced the yield. Leaving additional leaves at the top of the plant had no effect on the grade index but gave a greater yield.

TABLE IV

Response to Priming and Number of Leaves on Dark Tobacco at Tuchila

(a) Priming							
		No Priming	Half Priming		Full Priming	L.S.D. ($P=0.05$)	
Yield (lb./acre)	..	1,843	..	1,920	..	1,740	.. 155
Grade Index	..	44.74	..	47.08	..	51.00	.. 2.64
Crop Index	..	82,456	..	90,394	..	88,740	.. —

(b) Number of Leaves							
		Normal	Normal + 2		Normal + 4	L.S.D. ($P=0.05$)	
Yield (lb./acre)	..	1,686	..	1,795	..	2,023	.. 155
Grade Index	..	47.93	..	47.21	..	47.68	.. 2.64
Crop Index	..	80,810	..	80,742	..	96,457	.. —

4. ROTATION TRIALS

This series of trials is designed to show the effect of the preceding crop on the following crop of dark tobacco. One cycle of these experiments was completed in the past season at both Chitedze and Tuchila.

TABLE V
Mean Effects of Previous Crop on Dark Tobacco

(a) CHITEDZE						<i>L.S.D.</i> (<i>P</i> =0.05)
<i>Maize and</i>						
		<i>Maize</i>	<i>Beans</i>	<i>Groundnuts</i>	<i>Tobacco</i>	
Yield (lb./acre) ..	..	488	473	479	252	138
Grade Index ..	..	31.16	34.20	34.36	22.40	3.54
Crop Index ..	..	15,206	16,190	16,465	5,653	—

(b) TUCHILA						<i>L.S.D.</i> (<i>P</i> =0.05)
		<i>Maize</i>	<i>Cotton</i>	<i>Groundnuts</i>	<i>Tobacco</i>	
Yield (lb./acre) ..	..	557	463	619	346	129
Grade Index ..	..	32.2	31.4	39.1	30.7	6.2
Crop Index ..	..	17,948	14,541	24,207	10,613	—

At both Chitedze and Tuchila growing successive crops of tobacco resulted in significantly poorer returns. The preceding crop of groundnuts at Tuchila gave a significant increase in leaf quality as compared with maize and cotton when grown before tobacco.

Burley Tobacco

1. VARIETY TRIAL

Twenty-five varieties of Burley were tested and the results of the best 20 are given in the table below. There was no significant difference in yield between the five leading varieties. The variety most commonly grown in the Central Province, Stand Upright, had the highest grade index of any and this just about compensated for a slightly lower yield. There is little to choose between the varieties at the top of the table.

TABLE VI
Variety Trial—Burley Tobacco
(*Varieties Tested—25*)

<i>Variety</i>	<i>Yield</i> <i>lb./acre</i>	<i>Grade</i> <i>Index</i>	<i>Crop</i> <i>Index</i>
Gay's Yellow	1,038	54.91	56,997
Barnet Special	962	57.59	55,594
Kentucky 19	1,043	52.32	54,570
Kentucky 16	978	55.53	54,308
Mammoth Kentucky 22 ..	958	55.22	52,901
Stand Upright	878	58.53	51,389
Kelley	905	56.50	51,132
Station Standup	864	57.68	49,835
Harmony	968	50.07	48,468
Judy's Pride	835	56.56	47,228
Green Briar	796	58.20	46,327
Briarvet	876	52.53	46,016
Kentucky 41	845	52.71	44,540
Broadleaf Resistant ..	834	53.15	44,327
Kentucky 41A	950	44.70	42,465
Haronic	903	44.20	39,913
Kentucky 22	821	48.28	39,638
Kentucky 56	862	45.44	39,169
Haronova	778	49.22	38,293
Ottawa Strain 50,194 ..	888	41.21	36,594
L.S.D. (<i>P</i> =0.05)	128	10.30	—

2. FERTILIZER TRIALS

(i) Responses to Nitrogen and Phosphate

A series of fertilizer experiments were begun at Chitedze and on estates but only two of these were able to be harvested successfully and the results are given below. In both of them the effect of nitrogen was again outstanding. In the estate trial phosphate at 200 lb. supers per acre gave a significant response but not at Chitedze. This result was consistent with the soil analysis which was low on the estate and high at Chitedze.

TABLE VII
(i) Fertilizer Trial—Mbabzi Estate
(a) Nitrogen

		<i>Sulphate of Ammonia (lb. per acre)</i>			<i>L.S.D.</i> <i>P=0.05)</i>	
		0	100	200		
Yield (lb./acre)	.. ..	182	.. 338	.. 488	..	101
Grade Index	.. ..	30.65	.. 32.67	.. 38.40	..	4.24
Crop Index	.. ..	5,569	.. 11,036	.. 18,728	..	—

(b) Phosphate

		<i>Superphosphate (lb. per acre)</i>			<i>L.S.D.</i> <i>(P=0.05)</i>	
		0	200	400		
Yield (lb./acre)	.. ..	245	.. 382	.. 380	..	101
Grade Index	.. ..	33.22	.. 34.08	.. 34.41	..	4.24
Crop Index	.. ..	8,132	.. 13,029	.. 13,076	..	—

(ii) Fertilizer Trial—A.R.S. Chitedze

(a) Nitrogen

		<i>Sulphate of Ammonia (lb. per acre)</i>			<i>L.S.D.</i> <i>(P=0.05)</i>	
		0	100	200		
Yield (lb./acre)	.. ..	368	.. 596	.. 744	..	64
Grade Index	.. ..	38.92	.. 44.78	.. 49.79	..	6.06
Crop Index	.. ..	14,323	.. 26,689	.. 37,044	..	—

(b) Phosphate

		<i>Superphosphate (lb. per acre)</i>			<i>L.S.D.</i> <i>(P=0.05)</i>	
		0	200	400		
Yield (lb./acre)	.. ..	556	.. 538	.. 615	..	64
Grade Index	.. ..	46.42	.. 42.39	.. 44.68	..	6.06
Crop Index	.. ..	25,810	.. 22,806	.. 27,478	..	—

Turkish Tobacco

Observational experiments have been carried out in the growing of the Samsun variety of Turkish tobacco for the past two years in the Northern Province, where good results have been obtained. Formal trials were carried out last year at Chitedze, Mbawa and Lisasadzi on the time of planting and spacing of the crop.

TABLE VIII
Effect of Spacing on Yield, in lb. Cured Leaf per acre

		<i>3 ft. ridges</i> <i>2 rows × 9 ins.</i>	<i>3 ft. ridges</i> <i>2 rows × 6 ins.</i>	<i>18 ins. ridges</i> <i>1 row × 6 ins.</i>
Chitedze	.. ..	447	.. 420	.. 345
Mbawa	.. ..	1,158	.. 1,239	.. 1,196
Lisasadzi	.. ..	274	.. 275	.. 265

TABLE IX
Effect of Time of Planting on Yield in lb. Cured Leaf per acre

		<i>Mid-Jan.</i>		<i>Late-Jan.</i>		<i>Early-Feb.</i>
Chitedze ..	..	413	..	371	..	428
Lisasadzi ..	..	254	..	291	..	269

Although difference between treatments did not reach the level of significance in these experiments, it appears that planting can be done successfully on 3 ft. ridges, provided that two rows are planted per ridge and a high plant population secured. It is a matter of convenience whether ridges are made up 3 ft. or 18 ins. apart. The range of time of planting showed that no differences occurred, though previous observations had shown that outside this range the growth is too coarse if planted earlier and insufficient growth is made to yield a good crop if planted later.

Extract from the Agricultural Chemist's Report

LEAF ANALYSIS (WESTERN TOBACCO)

Eighteen grades of cured leaf were submitted by the Central Research Station for analysis of the nitrogen, phosphate and potash content, the results of which are shown below:—

TABLE X
Analysis of Western Tobacco Leaf

<i>Grade</i>	<i>Length</i>		<i>Type of Leaf</i>	<i>Per cent. N</i>	<i>Per cent. P₂O₅</i>	<i>Per cent. K₂O</i>
B1	23 ins. and over	..	Heavy bodied wrapper ..	3.58	.47	4.58
B2	23 " " "	..	Light " " "	3.52	.41	4.05
C1	23 " " "	..	Heavy bodied filler ..	3.40	.69	4.68
C2	23 " " "	..	Thin filler ..	3.28	.45	5.11
D1	19-23 ins.	..	Heavy bodied wrapper ..	3.60	.55	4.68
D2	" " " "	..	Light " " "	3.41	.48	4.68
E1	21-23 ins.	..	Heavy bodied filler ..	3.18	.49	5.01
E1	" " " "	..	Light " " "	2.88	.51	4.92
E2	19-21 ins.	..	Heavy " " "	3.25	.58	4.48
E2	" " " "	..	Light " " "	2.88	.59	4.92
F1	16-19 ins.	..	Pigtail wrapper ..	3.00	.54	3.76
F2	" " " "	..	Filler ..	3.19	.51	4.53
H1	19 ins. and over	..	Mottled leaves ..	3.12	.56	5.21
H2	Under 19 ins.	..	" " " "	3.02	.59	4.39
I1	19 ins. and over	..	Green leaf ..	3.41	.44	4.39
I2	Under 19 ins.	..	" " " "	3.32	.44	4.15
X	19 ins. and over	..	Low grade leaf. .	2.94	.50	5.11
X	Under 19 ins.	..	" " " " "	3.09	.50	4.68

COTTON

REPORT OF COTTON SPECIALIST, MAKANGA

		Cotton Season			
<i>Province</i>	<i>Type of Crop</i>	<i>Legal Sowing Dates</i>	<i>Harvest</i>	<i>Legal Uprooting Date</i>	
Southern } ..	.. Summer	15 Nov.-7 Jan.	Apr.-July	31st July	
Central } ..	.. Winter	16 Apr.-15 June	Oct.-Dec.	15th Jan.	
Northern ..					

Introduction

The Chitala experimental station, near Domira Bay, was opened by the Empire Cotton Growing Corporation in 1929-30. A survey of the potential cotton-growing areas of the country had shown that the plains lying to the south and south-west of Lake Nyasa offered the greatest scope for expansion of cotton acreage; Chitala was sited in this area.

For a variety of reasons, cotton has not proved to be a popular crop in this area, despite its advantages: the Lower River continues to produce the bulk of the crop. It has therefore been felt for some time that the cotton experiment station should be sited in the Lower River. The merits of a number of different sites have been considered by the Department of Agriculture and the Empire Cotton Growing Corporation, and it was finally decided that the existing Departmental station at Makanga should become the centre for work on cotton in place of Chitala.

Mr. J. M. Munro arrived at Chitala from Tanganyika on 4th October, 1955, to take over the cotton work in Nyasaland from Mr. H. C. Duckers, who has spent thirty-three years in the country, thirty of them as Cotton Specialist in charge of the Corporation's work. Mr. Munro moved his headquarters to Makanga in November, 1955.

The Chitala station was handed over to the Department of Agriculture on 1st January, 1956, along with such Empire Cotton Growing Corporation equipment as is not required at Makanga. Some 20 acres of land will be made available each year at Chitala for cotton experiments, if required, to supplement the programme at Makanga.

Makanga is situated three miles north of Chiromo, where the Shire and Ruwara Rivers meet. It is on the south-eastern edge of the main cotton growing area of the country, at an altitude of about 200 feet above sea level. The area of the station is 100 acres, comprising 41 acres run on an eight-course rotation; 14 acres of long-term experiments; 17 acres of irrigation; the remainder being occupied by roads, buildings, uncleared land, etc.

A further 100 acres, adjoining the station, were purchased by the Government in February, 1956; 33 acres have been cleared this season.

Two of the four new houses built by the Cotton Marketing Board (now the Agricultural Production and Marketing Board) have been made available for the use of the Cotton Specialist and the farm manager. The house on the farm has been converted into an office and laboratory, and a cotton seed store has been built alongside it. A new cotton store, with facilities for ginning, has been put up near the farm buildings, and two of the six additional African Staff houses planned have been completed.

Mr. E. O. Pearson, formerly of the Empire Cotton Growing Corporation and now of the Commonwealth Institute of Entomology, paid a visit to Nyasaland from 29th May to 10th June, 1956.

WEATHER

Chitala Station. Practically all the planting was completed in the week 11th to 17th December, 1955, when 2.37 ins. of rain fell. Seed sown towards the end of the week gave only partial germination, much of it lying dormant until the end of the month. There were over 10 ins. of rain in both January and February; March was wet, and late rains continued up to the end of April. The total, from November to May inclusive, was 38.32 ins., rather above average.

Makanga Station. The season as a whole was dry, and planting conditions difficult. The first heavy rains came on 8th December, but were short-lived, and no

further planting could be done until the last week in December. Between 3 ins. and 5 ins. of rain fell each month from December to April, which gave steady but not excessive growth.

Despite the rather dry conditions at Makanga, the station was inundated by floods from the Ruo River on 6th April. These were the result of the passage of cyclone "Edith" across Nyasaland, causing exceptionally heavy rain in the Ruo catchment area, when the soil was already saturated. The river flow reached catastrophic level, in the sense in which the term is used in the Report on the Shire Valley Project; that is, it would not be expected to occur more than once in a hundred years.

Fortunately, the cotton seed stocks were duplicated at Chitala, and there was no serious loss of breeding material. The cotton on Makanga, which was under water for more than 24 hours, was completely killed and only the few bolls which were already mature before the flood produced any cotton.

Cotton Breeding

CLB and CL. 20. Over the past few years, CL. 20 has shown a consistent superiority over CLB, the commercial cotton of Nyasaland, in staple length and spinning quality (cf. Table 2). CL. 20 yarn has shown no undesirable characteristics, such as neppiness, which might indicate that its lint is too long or fine for conditions in Nyasaland; it seems that the country can produce a cotton of a longer staple than the present 1 in. of CLB.

CL. 20 does not appear to be inferior to CLB in jassid resistance, and trial results show no consistent differences in yield or ginning percentage. The rather shorter and more compact habit of CL. 20 is a desirable character in the very lush growing conditions of this country.

The Department of Agriculture has decided to introduce CL. 20 in place of CLB in the Central and Southern Provinces, pending the testing and multiplication of the Albar 51 strains (*see below*); all the seed produced in the Fort Johnston District and at Rivi-Rivi this year will be planted at Toleza and in the Lisungwe area next season. A suggestion that CL. 20 may be unsuitable for the Lower River is not confirmed by past trial results; but an extensive series of trials will be carried out there next season to compare its performance with that of CLB and the Albar 51 strains.

The CLB selections made last year for high ginning percentage have been discarded to make way for types with longer lint, except for a few progenies with other characters of interest; these progenies may be used in the crossing programme with Albar 51.

Albar. Bacterial blight has been an important factor in the poor crop this season, and breeding for resistance is considered a very worth-while project. At Makanga, the early planted (15th November) irrigated plots had already yielded over 600 lb. per acre of seed cotton before the flooding on 6th April. They were planted with CLB, and 62 per cent. of the cotton was Grade 2; almost all of the damage was due to bacterial boll rot. Although these plots were irrigated, similar conditions can occur in a wet season without irrigation. At Chitala, the difference in appearance between the CLB and the Albar strains and crosses was very striking—not only better opening, but more fruit set. The variety trial at Chitala (Table 1) confirmed these differences in terms of yield for the second year in succession: the six Albars tested outyielded CLB by amounts ranging from 25 per cent. to 48 per cent. (Table 1).

TABLE I

Cotton Variety Trials

Variety	Chitala 1956		Nyabubu 1956		Mean of 1955 trials	
	Lint in lb./acre	Gin %	Lint in lb./acre	Gin %	Lint in lb./acre	Gin %
CLB. ..	159	36.4	126	31.9		
CL. 20 ..	178	35.4	127	31.3		
Albar 625 ..	36.8	36.8	242	32.9		
.. 629 ..	226	37.8	192	34.9		
.. 637 ..	220	37.6	260	34.2		
.. 639 ..	226	37.4	296	33.6		
.. 640 ..	230	38.4	215	34.3		
.. 645 ..	212	40.0	239	36.5		
S.E. ..	± 8.9					
Sign. Diff.						
(P = .05) 25.						

NOTE.—Ginning percentage is determined on a hand-operated roller gin, as a saw gin is unsuitable for small samples. Roller ginning has been found to give a figure about 2 per cent. higher than saw ginning.

These Albars are selections from Albar 51 brought from Namulonge in 1953, which, without any crossing or local selection, have done extremely well in competition with the local variety both last season and this. Unless the 1957 trials show a complete reversal of form, one of these strains will replace CLB and CL. 20 as the standard variety in central and southern Nyasaland. They have not yet been tested in north Nyasa, where dry season cropping makes it less important to have resistance to bacterial blight.

TABLE II

Lint and Yarn Characters

CHITALA AND MAKANGA VARIETY TRIALS—1955

Variety	Effective Length		Count × Strength		Yarn Appearance	
	1/32		Product			
CLB ..	36.5	1,968	3.0			
CL. 20 ..	39.5	2,276	2.5			
Albar 625 ..	40	2,131	2.5			
.. 629 ..	39	2,066	2.0			
.. 637 ..	41	2,189	2.5			
.. 639 ..	38.5	1,994	3.0			
.. 640 ..	39.5	2,122	2.75			
.. 645 ..	39	1,970	2.5			

The Albar 51 strains lie between CLB and CL. 20 in spinning quality (Table 2). Jassid resistance is similar to that of CLB. A. 637 has the best overall record, and is to be multiplied as far as possible on the Toleza farm of the Agricultural Production and Marketing Board in 1956/57. Two others will be grown on a smaller scale at Makanga and Chitala, and the final decision on the best strain will be made next year.

Albar Crosses. Last season, selections were made from two panmixus bulk constituted in 1952—Albar 49 × CL. 20 and Albar 49 × BP. 52 × CL. 20. These were grown in progeny rows this year; there appeared to be segregation into two main habits of growth, but a closer study of this was interrupted by the floods. A selection of about 120 progenies showing the highest lint index has been made, and as many as possible will be tested in trials next season, with particular attention to any correlation between habit and performance.

Breeding for resistance to bacterial blight will be further developed by selection in these progenies, with field testing of resistance by stem inoculation; and by a new series of crosses, using the best Albar 51 strains instead of Albar 49.

Long Staple Uplands. The long staple uplands being tested at Karonga in the Northern Province were again outyielded by CLB from the Karonga District; yields per acre were poorer than last year as a result of early flooding and rat damage. BP. 52 showed up better than last year, but the two strains from the Eastern Province of Tanganyika are the most promising of the imported varieties. Yields are given in Table 3, together with the spinning test results on the 1954 crop.

TABLE III
Karonga Long Staple Upland Variety Trial

Variety	1955 trial Lint in lb./acre	Gin %	1954 trial Effective Length 1/32	Count × Strength Product	Yarn Appearance
CLB	412	32.8	36.5	2,000	3
Karonga Local					
CL. 20	294	33.0	38.5	2,298	2.5
ex Chitala					
CLA	352	31.8	40	2,212	3
ex Tanganyika					
47/10	339	30.6	41	2,380	3
BP. 52	340	32.6	39.5	2,518	2.5
C(50)20					
Wilds No. 11 ..	197	34.8	44.5	2,600	3
S.E.	± 20.6				
Sign. Diff.					
(P= .05)	58				

Ginning Outturn. The high proportion of light seed found in all samples from the Central and Southern Provinces has undoubtedly affected the ginning percentages shown in Table 1, which are unusually high in both trials. While they have some value in comparing one strain with another, they provide no further evidence on the difference in ginning outturn between the two Provinces.

Cross-Pollination. In each of three CLB bulk plots, single ridges were planted with red-leaf cotton, kindly supplied from Namulonge. Seed was picked from individual ridges of CLB, up to 20 drills on either side of each red-leaf row: samples of 500 seeds were sown from each of these ridges. Only two red-leaf seedlings appeared, both occurring in one sample (about 300 seedlings) from a ridge adjacent to a red-leaf cotton row. The remainder were all true to type. The amount of cross-pollination taking place between adjacent cotton ridges at Chitala appears to have been negligible.

Origin and special Characteristics of the main Cotton Strains Mentioned

CLB ..	Crown Land Bulk, the commercial cotton in Nyasaland, mainly of U.4 origin.
CL. 20 ..	A selection from CLB, with better lint quality.
Albar ..	A general term for selections from Nigerian Allen, highly resistant to bacterial blight. Two series of selections have been made, Albar 49 in 1949, and Albar 51 in 1951.
A. 637, etc. ..	Selections made at Namulonge from Albar 51, chosen as suitable for Nyasaland conditions.

Pests and Diseases

Red Bollworm, Stainers and Bacterial Blight are discussed by Mr. E. O. Pearson in the report of his visit to Nyasaland, extracts from which appear at the end of this section. We are indebted to the Colonial Office for permission to reproduce parts of this report, as well as to Mr. Pearson himself.

Jassid. Jassid was or had been present in nearly all the cotton visited in the Central and Southern Provinces during the season, and was seen as early as January in large numbers in some parts of the Lower River. Typical discolouration of the leaves was general later in the season, but only rarely was the damage serious enough to cause distortion of the leaves. Several damage was, however, noted in one or two fields near Tengani. In Lisungwe the main attack was late, and caused some distortion of the upper leaves of the plants: some late-planted cotton was probably checked in growth.

A higher standard of jassid resistance is desirable, although the present standard seems to be just adequate for the conditions. Plots at Chitala planted with strains from the Eastern Province of Tanganyika, were markedly more susceptible than the other varieties being grown.

Helopeltis and *Apian Weevil* did some local damage, but these and other pests and diseases were of very minor importance.

Seed Dusting. A trial to test the effect of the standard seed dressing with "Perecot" dust on yield was laid down at Chitala, but an examination of the seedlings at about six weeks old showed no leaf or cotyledon lesions due to bacterial blight in either the treated or the untreated plots. Seed-borne infection had in this case apparently been absent or ineffective, and later infection appeared to occur equally in both treatments; there was no significant difference in yield at the main picking.

EXTRACTS FROM REPORT BY MR. E. O. PEARSON, DATED JULY, 1956

The Background to the Situation in Nyasaland

Cotton is grown in Nyasaland in three main areas: (a) the Lower Shire Valley (commonly called the Lower River), which lies at an altitude below 200 ft.; (b) the Central Shire and Lake-shore areas, at from 1,500–2,000 ft.; and (c) the Northern Province, at 1,600 ft. The last, is a floodland area where cotton is grown in the dry season, and does not concern this Report; in both former areas cotton is now a rain-fed crop, planted in November–January and harvested in June–July,—the legal close season being from August–October.

The principal insect pests are red bollworm (*Diparopsis castanea* Hmps.) and two species of cotton stainer (*Dysdercus fasciatus* Sign. and *D. intermedius* Dist.), with jassid (*Empoasca facialis* Jac.) of less importance. The only disease of importance is bacterial blight (caused by *Xanthomonas malvacearum* E. F. Sm.), part from stainer-borne internal boll disease caused by *Nematospora* spp.

Detailed investigations of red bollworm were made between 1939 and 1945. At that time, as today, by far the greater part of the cotton crop was produced in the Lower River, and red bollworm damage was particularly severe there. Work was accordingly concentrated on the problem in that area. In their Report on that work, Pearson and Mitchell (6) explain that *Diparopsis* is able to carry over from one cotton season to the next by means of long-term pupae formed in the soil, from which moths emerge during the following rainy season. The emergence, which is largely independent of the date of pupation, shows in the Lower River a first peak in December and a second, and usually much larger one, in March–April.

It was suggested that red bollworm could be completely controlled in the Lower River by delaying planting so that long-term pupae completed their emergence before any food was available from the new crop. This would imply growing the whole crop on irrigated or seasonally-flooded land, which would not be possible until the flow of the Shire River can be controlled. It was recommended, as an interim measure, that cotton should be grown in such a way as to limit fruit production to that time of year when, it was believed, only short-term pupae would be

produced. This involves planting the cotton early, under conditions promoting the maximum rapidity of development, and cutting it out in July in order to avoid the flush of fruiting that accompanies the August rise in temperature. The legal crop season in the Lower River, would in this way, be brought into line with that of the Central and Lake-shore areas, but it was expected that such a regime would be more effective against the pest in the former area than in the latter ones. This is because, at the higher altitudes: (a) formation of long-term pupae begins rather earlier in the calendar year, and thus some considerable production of carry-over pupae cannot be avoided; and (b) emergence of moths from long-term pupae tends to be uni-modal, with a peak in January, so that the full onslaught is felt before the plant has had time to set a crop of bolls.

Early planting and early uprooting of cotton was introduced into the Lower River as Government policy in the 1951-52 season. There had been a very poor crop in 1951, due to a drought that had prevailed from February onwards, and advantage was taken of this to introduce the new regime without preceding it by the non-cotton year that would otherwise have been necessary. In order to promote the rapid growth and early setting of the crop that is the essential feature of this method of bollworm control, the interplanting of cotton in maize was prohibited and the whole cotton crop was grown in pure stand. One of the major difficulties foreseen by the authors of the 1945 Report was thus removed, by a bold and, as it turned out, successful stroke.

A very marked improvement in yield on the Lower River has followed this change of regime, and has been more than enough to offset any fall in the acreage planted. Estimates of yield of seed cotton per acre in 1951-52 and 1952-53 were of the order of 500 lb., more than three times the average recorded in 1939-44, and in the four seasons so far completed under the new regime the total production in the Lower River has ranged between 5,000 and 7,300 tons of seed cotton. The latter figure has only once been exceeded in the history of the Lower River.

The benefits of the change in regime on the Lower River have, however, been offset latterly by an increase in the proportion of cotton bought as Grade II. Over the whole of the Lower River, the percentages of Grade II in the four seasons 1951-52 to 1954-55 have been 9.6, 20.6, 20.2 and 31.1*. The bulk of the staining in this Grade II cotton appears to have been due to stainer-borne *Nematospora* and in the last of these four seasons, some 50 per cent. of the seed from the Grade I cotton was not viable, suggesting continued heavy infestation by stainers after the bolls had passed the stage at which the lint could be affected. These figures compare with an average of about 15 per cent. Grade II cotton in the five years 1940-44, under the previous regime.

Numerical records of the stainer populations in cotton in recent years are not available, but it appears that immigration of adults of *D. intermedius* and somewhat later) *D. fasciatus* has occurred in February and that populations subsequently bred in the crop have been extremely high. This is in marked contrast to the situation that prevailed previously.

The preceding paragraphs refer principally to the Lower River areas. Until comparatively recently it had been believed that with December sowing, and with harvesting completed by the end of July, infestations by red bollworm in the Central and Lake-shore areas could be satisfactorily contained. Thus in 1952 it was reported that "the close season with a minimum of three months . . . has resulted in good control of red bollworm . . . experience at the Cotton Experiment Station (Lake-shore area) suggests that this can be maintained indefinitely . . . provided

*These figures have been calculated from rough totals of individual market figures kindly supplied by the Cotton Marketing Board, excluding certain doubtful records which I have not been able to verify.

there is no relaxation of control measures". The attacks of red bollworm in the three years that followed were so severe, however, as to lead to a reversal of this appreciation of the situation, and in 1955 it was stated that "in the central areas represented by Chitala (the Cotton Experiment Station), the close season measures at present in use do nothing appreciably to control the ravages of red bollworm". Over the same period there has also been an increase in the populations of *Dysdercus* infesting cotton, with a corresponding rise in the amount of stained cotton. It had always been realized that considerable infestations of *Dysdercus* were liable to be bred up in cotton in the central areas, but that, provided the crop was formed rapidly, the bulk of the bolls would mature before the stainer infestation became serious. Crops retarded, e.g., by bollworm infestations, would be liable to heavy stainer damage, and this appears to be what has happened since 1952.

Considerable attention has been paid in recent years to the occurrence in the Nyasaland crop of bacterial blight, which previously had not been considered to be of importance in the territory. This was particularly the case in the Lower River under the old regime, when, although bacterial infection was common in bolls that had been damaged by insects, loss of flower buds and bolls due to direct bacterial infection was noticeably rare. In the Lake-shore area, although the angular leaf spot and blackarm phases have been sufficiently severe in occasional, very wet seasons to show up inter-strain differences in susceptibility, bacterial boll disease has never been recorded as accounting for more than a small percentage of the crop set, although it has been thought that it might be a cause of excessive shedding. The possibility of the disease attaining serious proportions under the summer crop regime in the Lower River was envisaged by Ducker in 1952, and two years later Wickens drew attention to the fact that although the crop at the time of his visit (February, 1954) had suffered but little from the angular-leaf-spot; vein-blight and blackarm phases that were then prevalent, the greatest danger lay in later possible loss of crop through bacterial boll disease.

The Situation in Nyasaland in early June, 1956

Throughout the Lower River the cotton seen had grown well and comparatively regularly; there was a noticeable absence of the crop failures, due to late planting or excessive maize competition, that used to be common under the old regime and of the excessively woody, tangled growth that was previously associated with early planting. Plants on the whole were well formed and, although robust, were not unduly large. Their most striking feature was the extent to which a crop of bolls had been set at the base and in the centre of the plant. This was particularly the case from Chiromo and Ngabu southwards, where the bulk of the bolls that would open had done so, and plants were becoming senescent, with relatively little sign of a top crop. Northwards from Ngabu, into the main part of Chikwawa District, there had been rather more loss of fruiting points at the base of the plants, and the crop had thus been set later, and was present in all stages, from open bolls to partly grown green bolls and flowers. Such fields were still carrying abundant green leaf, but there were relatively few that still showed signs of vigorous recent growth.

Red bollworm larvae could be found in the green bolls, but not very readily, and there was only slight evidence of their activity in bolls that had opened or aborted. This was the case even in fields where early shedding had been heavy, and suggested that such shedding might not have been caused by bollworm. At this stage in the season it is difficult to get good evidence of what has happened earlier on, but examination of the oldest sheds, that could be found on the ground below the plants, did not show a preponderance of bollworm damage. I was satisfied, in short, that the incidence of bollworm in most of the Lower River crop is not now sufficient to prevent the formation of a large, early, potential crop of bolls, and that the main object of the early cropping regime has been achieved.

This potential crop, however, was very far from being realized. A large proportion of the bolls that had set had failed to open properly, if at all, and of the locks that were pickable, a very high proportion were stained. I should be surprised if the proportion of Grade 2 cotton from the current crop was not even higher than that recorded in 1955, and it must be emphasised that this only represents a proportion of the real loss, which is mainly in the form of bolls that do not open at all or that produce locks that are unpickable.

The primary cause of the bad opening was undoubtedly attack by stainers, which had evidently started before boll-opening and had thus caused not merely discolouration of the lint, but, to a much greater extent, abortion of the lock. Any green bolls present were heavily punctured and infected. The damage caused by stainers to bolls, low down on the plant, had been partly obscured by secondary infections favoured by late rain, which had also been directly responsible for flattening and matting the lint in bolls that had not opened well, but that in dry, sunny weather would have yielded some pickable cotton. These secondary effects account for the widespread and very natural belief that the crop had been spoilt by wet weather.

There were considerable populations of *Dysdercus intermedius* and *D. fasciatus* present in the cotton fields, chiefly as late-instar nymphs and freshly moulted adults. The former species was usually the more numerous. Except, where the early fruiting points had been lost and the crop had therefore been set late, and thus showed all stages of boll development, including recently opened bolls in which early instar nymphs were abundant, the stainer populations appeared to be dispersing. In some fields the populations left seemed inadequate to account for the damage exhibited by the crop: in such cases few sound seeds could be found and it seemed likely that stainers had exhausted their food supply and left.

A feature of the Lower River crop, that was unfamiliar to me from past experience, was the extent of bacterial blight. In parts of the Ngabu area, and in west Chikwawa, this took the form of classical blackarm, with vein lesions and truncation of the fruiting branches, but the boll-disease phase was widespread, not only in association with bollworm punctures but also, and principally, as direct lesions, particularly at the base of the boll. I suspect that where early shedding had been severe a considerable amount of it may have been due to bacterial disease.

Mention is made above of the comparative rarity of direct damage by bacterial blight under the old regime. Under that regime, cotton was not sown until mid-January or very often later. By then, infected trash from the previous year's crop had been exposed to upwards of two months' rain, and may therefore have suffered considerable destruction of the pathogen, even though there is some doubt as to how complete such destruction may be, or as to the precise mechanism by which moisture causes it. Moreover, under the old regime, practically the whole cotton crop was intersown in maize, and thus very largely protected from the rain-splash and driving storms that are responsible for disseminating and promoting bacterial infection. Under the new regime, the cotton is planted in pure stand on the earliest rains, and is thus far more liable than in the past to infection from the previous year's debris, particularly as crop rotation is as yet little practised. In 1956, the rainfall in the early part of the season was distinctly scanty, but later on was heavy and protracted, being exceptional in April and maintained throughout May, right up to the time of my visit. Precisely the conditions had been provided, in fact, that Wickens had foreseen in 1954 as liable to lead to an outbreak of bacterial boll disease.

The general pattern of events in the cotton crop in the Central and Lake-shore areas visited (Lisungwe, Balaka and Chitala-Salima) did not seem essentially different from that described above, although the plants had reached a more advanced state of senescence. The principal feature was an increase in the intensity of the attack

by red bollworm as one moved north; at Lisungwe this had been relatively light, but stainer had been very severe; at Balaka (where all the cotton seen was on the Rivi Rivi estate of the Nyasaland Farming Corporation), bollworm had apparently caused considerable early shedding and damaged about 50 per cent. of the bolls that had set, although multiple infection with stainer and bacterial disease would in any case have destroyed most of the latter; at Chitala, early shedding had been very serious, and many plants had held no bolls at all. Plants at Chitala had grown very big and some had succeeded in maturing a middle crop that had opened fairly cleanly; above this, however, everything had been ruined by stainer, and there was a very large population of both *D. fasciatus* and *D. intermedius* present, in all stages of development.

The incidence of bacterial blight was particularly severe on the Chitala Experiment Station, affording a valuable contrast between the behaviour of the strains and selections out of Crown Land Bulk (CLB), and that of the blackarm-resistant Albar strains and panmixis bulks. The CLB strains showed typical blackarm symptoms, particularly severe in an exhaustion-plot experiment, and, amongst the shed material, there was a considerable preponderance of fruiting forms that did not show bollworm damage. The Albar strains, on the other hand, had held very much more of the early crop and, having opened this (or such of it as had not subsequently been damaged by stainer) had reached a state of natural senescence, contrasting with the more sustained, ranker growth of the susceptible strains. This observation, strengthened by suspicion that a substantial part of the early shedding that had been seen in the Lower River, may have been due to bacterial boll disease, and not to red bollworm.

As regards red bollworm, there is no room for further manipulation of planting and uprooting dates as a means of controlling the pest in rain-grown cotton. It was always recognized that the early-cropping system on the Lower River would inevitably continue to produce some long-term pupae, and that their effective survival to the next year's crop should be minimized by the early digging or ploughing of old cotton fields and by mulching. A spread of the use of draught oxen would help here. It is extremely important that the present uprooting date is maintained. Requests for its postponement are never made, except in the particular circumstances that make its enforcement essential—namely the existence of a crop of green bolls at a time of year when they are certain to give rise to carry-over pupae.

For further mitigation of red bollworm attack, one can look only to biological or to chemical control. The former would depend mainly on the possibility of finding a suitable parasite of the South American cotton bollworm, *Sacadodes pyralis* Dyar, which is discussed elsewhere; there is a further possibility that parasites of the Sudan bollworm, *Diparopsis watersi* (Roths.), might be effective against the southern African form. The possibility of chemical control would depend on an intensification of the work that has shown promise in Southern Rhodesia, and its application to African-grown crops.

Insecticidal experiments against red bollworm have been made at Gatooma for a number of years, but have only recently given definite results. In the past two seasons and the present one, trials have shown that the use of DDT and BHC mixtures, Parathion alone and with DDT, and Endrin alone, can give very large percentage increases in yields, particularly when applied at the start of flower-bud formation, in the form of emulsions, and at weekly intervals over a period of two months. The yields resulting have been of the order of 600 lb. seed cotton per acre as against a little over 100 lb. on untreated controls. The approach in these trials has been an empirical one, and it is difficult to draw conclusions from them on many of the most vital points (e.g., formulations, methods of application), but they are of very great importance in demonstrating that it is possible to effect some control of *Diparopsis* by chemical means.

The recent prevalence of stainer damage in the Lower River crop suggests that in avoiding one pest we have run into another. During the early part of the rainy season, stainers breed on the old shed seed of a number of arboreal host plants, notably baobab (*Adansonia digitata*), *Sterculia appendiculata* and *S. quinqueloba*, and on the newly-ripened fruits of *S. africana* and the kapok, *C'eiba pentandra*. Under the old regime, invasion of the cotton crop did not occur until April-May and this was probably derived from a generation intervening on herbaceous hosts (chiefly *Hibiscus* spp.) which are not very numerous, and which in consequence did not give rise to any large invasion of cotton. In the present changed circumstances, cotton must provide a large food supply available directly to the generation bred in the early rains on arboreal hosts. The fact that stainer damage was only slight in the first season of the new regime (1951-52) argues against this hypothesis. The progressive nature of the rise since then, however, suggests another possibility. An ample food supply now intervenes at a time when climatic conditions are most suitable to breeding, and at a time when, in the past, there had been somewhat of a gap in the sequence of stainer food plants. As a result, the whole stainer population of the Lower River may have increased and, while still fluctuating seasonally, may be doing so at a much higher level than was the case before.

Against this suggestion, that serious damage by stainer is an inevitable sequel to control of red bollworm by early cropping, is the fact that increased damage by stainer has not been confined to the Lower River, but has occurred in the Central and Lake-shore areas, where there has been no change in planting dates, both in the present (1955-56) season, and in the 1954-55 one. An explanation might be sought in the weather: the protracted rains of the present year have undoubtedly fostered stainer multiplication in both areas, and the same holds for the Lower River and Central areas in 1954-55. In that year the Lake-shore crop was late-planted and provided an opportunity for a large build-up of stainer in the crop. Whatever the cause of the severe staining, recently encountered throughout the summer-crop areas, it merits investigation. The object should be (1) to determine more accurately than is at present known the sequence of breeding on wild host plants, (2) to investigate the possibility of breaking that sequence by eradication of one or more arboreal hosts, or of the stainer populations on them, (3) to investigate the possibility of direct control of stainers on cotton with insecticides.

The incidence of substantial infections of bacterial blight in the Lower River crop seems very likely to be bound up, as suggested previously with the altered cropping regime. Whether there has really been a general increase in incidence in the rest of the summer-crop areas, or whether this reflects a succession of seasons peculiarly favourable to the disease, accompanied possibly by a greater awareness of its potentialities for damage, is a matter for speculation. It is perfectly clear, however, from this season's experience, that it will be, at the very least, a valuable insurance to concentrate on the selection and multiplication of blackarm-resistant strains, and in the meantime to continue seed-treatment of the commercial seed supply.

Irrigation

The irrigated land at Makanga is intended for preliminary trials of the crops which may play a part in the agricultural pattern of the Lower River as the Shire Valley Project develops. As a result of the floods, however, the season was a failure: most of the wet season (summer) crops were lost, and it was impossible to get land ready in time for any planting in the 1956 dry season.

Under irrigation, it is possible to plant wet season crops in good time, independent of the planting rains. The early planted cotton, mentioned earlier in this Report, gave 600 lb. per acre of seed cotton by the beginning of April. A maize crop planted

at the same time, 15th November, yielded over 5,000 lb. per acre of fresh cobs; these cobs were damaged in the floods, but the yield of grain can be estimated at around 4,000 lb. per acre.

Twenty varieties of sugar cane were established in small plots in December, 1954, and January, 1955. These survived the flooding without damage, and the first cut was taken in July, 1956. Yields of eight varieties, estimated from sample weighings, exceeded 50 tons per acre of cane. Most of these had already flowered before cutting, and estimates of sugar content might have been affected; samples will be taken for this purpose prior to the next cutting.

Husbandry and Rotation Crops

Yields of seed cotton and maize at Makanga, after the floods, gave no measure of the crop responses to experimental treatments, but stalk weights were recorded in two trials which were planted to cotton.

One trial measured third year responses to fertilizers (second residual) and to various preceding crops, but it showed no significant differences in stalk weights. The first residual responses to manuring in this trial last season were also negligible; there were then four indicator crops—cotton, maize, groundnuts and sorghum.

The second trial, compared flat cultivation with planting on ridges, with and without cross ties, combined in a factorial arrangement with mulching treatments. Stalk weights did not differ between the flat and ridge cultivations, but the plots with a surface mulch of sorghum and maize stalks gave a much higher yield of cotton stalks than those without mulch.

TABLE IV
Ridging and Mulching Trial

YIELDS IN LB. PER ACRE OF COTTON STALKS							
		<i>No</i>		<i>Low</i>		<i>High</i>	
		<i>mulch</i>		<i>mulch</i>		<i>mulch</i>	<i>Mean</i>
Flat	..	1,977	..	4,560	..	4,237	.. 3,588
Ridge only	..	1,870	..	2,556	..	4,062	.. 2,827
Ridge and Box	..	2,233	..	2,609	..	4,465	.. 3,100
Mean	..	2,027	..	3,244	..	4,251	
Sign Diff. (P= 0.5) 896							
S.E. of a single treatment mean ± 543							
Interactions are not significant.							

Trials of maize, groundnut, sorghum and soya bean varieties were carried out at Chitala for the Department of Agriculture.

ROTATION EXPERIMENTS

The programme of Rotation Experiments in Nyasaland has two major objects in view. The first and shorter term aim is to discover the effect of the major crops in cultivation upon the crops succeeding them in the rotation, with a view to fixing the

best sequence of crop in the arable courses. This includes experiments to determine which crop does best in the first arable year after breaking leys and bush fallows at different times of year. The second and longer term aim is to discover for how long land must be left fallow or planted to a ley, and for how long it can be cultivated at a stretch, while still maintaining yields. These experiments include different basic forms of ley management, and different basic levels of manuring of the arable crops.

The ultimate object is to provide data on which to recommend rotations for different areas, combining maximum productivity per cycle with maintenance of soil fertility.

On the short term projects, the following observations can be made. It is very seldom that one gets as good a yield from planting a crop two years in succession on a piece of land, as from rotating the crop with some other one. Cotton may be an exception to this general rule. Secondly, groundnuts have proved to be an exceptionally good crop for maize and tobacco. Thirdly, unless the grass is turned in really early (in February) it is best not to grow maize or other crops requiring much nitrogen as the first crop in the rotation. Groundnuts or tobacco properly fertilized are a safer proposition.

GRASSLANDS

There is, at the moment, a very small acreage of planted grassland in Nyasaland. European estates, mostly those with dairy herds, have planted limited areas of permanent pastures and African Master Farmers are just beginning to plant grass. There is, however, no widespread use made of the grass ley in a rotation to provide feed for cattle and to maintain fertility.

It is thought, and has been confirmed by experiments, as far as they have gone, that this is one good method of increasing productivity. As the population increases, more and more of the land is taken up with gardens and becomes unavailable for grazing. It therefore becomes increasingly important that the same number of stock, or more if possible, should be adequately fed from less and less land. Accordingly, the work in progress is directed to ascertaining the best grasses for different areas and methods of management. At Chitedze a large collection on grasses is maintained and the better ones distributed for observation trials at other stations. The most promising are *Chloris gayana* (Mpwapwa strain) *Cynodon pleistachyum*, *Panicum coloratum* var Makarikari. Fertilizer trials have been conducted at Chitedze and Bvumbwe and variety trials will be carried out in the future.

CHITEDZE FERTILIZER TRIALS

The Rhodes grass fertilizer trial was in its fourth year from establishment and the yields are summarized below. There was no sign of the grass dying out even in the unfertilized plots.

TABLE I

Yields of Air-dry Rhodes Grass Hay in short tons per acre

Nitrogen application				Superphosphate		300 lb. per acre		Mean
				nil				
Nil.	..	..	..	1.31	..	1.02	..	1.17
200 lbs/acre S/A	..	..	..	1.53	..	1.73	..	1.63
400	..	..	S/A	2.96	..	3.10	..	3.03
600	..	..	S/A	4.00	..	4.57	..	4.29
800	..	..	S/A	4.30	..	4.62	..	4.46
1000	..	..	S/A	4.40	..	4.46	..	4.43
1200	..	..	S/A	4.51	..	4.93	..	4.72
1200 lbs/acre nitrate of Soda				4.61	..	5.01	..	4.81
Mean	..	..	..	3.45	..	3.68	..	3.56
L.S.D.								1.08

The yields have dropped, compared with previous years, but there is marked response to applications of sulphate of ammonia up to 600 lb. per acre but any further increase in nitrogen above this level is not reflected in greater crop. There is little difference between the effect of nitrogen as sulphate of ammonia or as nitrate of soda. The chemical analysis at the end of this section should be noted.

The Rhodes grass management trial again showed a straight line response to nitrogen applications up to 400 lb. per acre. A dressing of at least this amount is required before any residual response is shown after the first cut. A single cut gives the greatest yield but it is very coarse and difficult to handle besides being of lower feeding value. Three cuts reduces the yield to a low figure and two cuts seems to be the optimum. There is little difference in yield between different times of application.

TABLE II

Rhodes Grass Management Trial

Yields in short tons dry weight hay

Nitrogen as Sulphate of Ammonia								
nil	..	..	1.44					
200 lbs/acre	..	..	2.40					
400	..	..	3.33	..	..	..	L.S.D.	.. 0.288
Time of Application of N.								
Early	26/11/55		2.68					
$\frac{1}{2}$ early and $\frac{1}{2}$ late			2.79					
late	25/1/56		3.13	..	..	..	L.S.D.	.. 0.354
Number of cuts								
One cut	..	..	3.46					
Two cuts	..	..	2.31					
Three cuts	..	..	1.40	..	..	..	L.S.D.	.. 0.288
Mean	..	..	2.39	Coef. of variation				18%

BVUMBWE VARIETIES

Observation plots were started at Bvumbwé in 1952 and results in the ensuing period have enabled certain specific recommendations to be made to farmers served by this station.

Permanent Pasture

Star Grass No. 2 (*Cynodon plestostachyum*) planted 3' $\times$ 3' in February is fit for light grazing by the following November. It establishes itself quickly and responds most vigorously to manurial dressings of 400 lb/acre which prolong the grazing days per year.

Kikuyu (*Pennisetum clandestinum*) has failed to produce a permanent sward in several localities. Small plots have, however, produced a remarkable stand in face of competition from Rhodes Grass. Further trials should be made before it is rejected.

Makarikari (*Panicum coloratum* var.) provides more fodder than star grass in the dry season. It has to be propagated vegetatively. The Bambatsi Panicum can be used where sowing is preferred; at Bvumbwe the size of leaf and vigour does not compare favourably with Makarikari.

The African Foxtail, *Cenchrus ciliaris*, establishes itself well from seed. The erect form produces more bulk; it appears most suited to a mixed pasture.

Leys

Rhodes grass (*Chloris gayana*) is most outstanding for a 3–4 year ley. The Mpwapwa strain is the most vigorous tried at Bvumbwe; being a pure strain, seed collection is fairly easy. The Katambora strain produces thinner leaves and stem. Teso is a mixed strain. If established, pure stand 10–12 lb. per acre of Mpwapwa seed is required. If intersown in maize, after the second cultivation, 5 lb. per acre is required.

The West Coast strain of Napier grass (*Pennisetum purpureum*) is planted for silage purposes. It is not recommended that it be grazed more than occasionally since the stand can otherwise be quickly killed out.

Mixtures

Legumes have been tried with several grasses. The most satisfactory for all round purposes appears to be the Fiji Clover *Desmodium intortum*. *Glycine Javanica* has persisted in Rhodes grass for nearly five years and silage made from this mixture showed by analysis a much improved protein content. *Stylosanthes gracilis* produces a type of growth most nearly like clover. It establishes easily and persists in spite of grazing.

Mixtures of Makarikari and Rhodes have been dominated by the Rhodes, the Makarikari reaching negligible proportions within three years.

Rompha grass has attracted much attention recently. It establishes well and its value lies in the green bite that it provides in the winter. It is essentially a grass for very low rainfalls.

Panicum maximum and *Setaria sphacelata* (Bua strain) have not grown well and quickly die out. Other strains of these genera may do better but it is doubtful if they could better any of the aforementioned.

FERTILIZERS

The fertilizer trial, reported last year on the Teso strain of Rhodes Grass sown in February, 1952, is now in its third harvest year. There are no signs of the yields of hay falling off. The unfertilized plots remain about the same but the fertilizer is having a slightly cumulative effect. The only exception is the lowest dressing of sulphate of ammonia which has been superseded by that of nitromonical. The rainfall was normal (54 inches).

It appears that the value of the higher rates of fertilizer is not sufficiently realized. If the yield of hay (or cut grass) is valued as low as £4 per ton the following situations arise on the 1956 yields:

TABLE III

<i>Rate of application</i>	<i>Yield hay (short tons)</i>	<i>*1 Cost £ *2</i>	<i>Return £</i>	<i>Surplus £</i>
Nil	2.78 ..	— ..	11.12 ..	11.12 ..
100 lb/acre Sulphate of ammonia every 3 months (400 lb.)	6.70 ..	6.43 ..	26.80 ..	20.37 ..
200 lb/acre S/A/ every 3 months (800 lb.)	8.74 ..	12.86 ..	34.96 ..	22.10 ..
300 lb/acre S/A every 3 months (1200 lb.)	11.06 ..	19.29 ..	44.24 ..	24.95 ..
100 lb/acre S/A every month (1200 lb.) ..	15.79 ..	19.29 ..	63.16 ..	43.87 ..
100 lb/acre Nitromonical every 3 months (400 lb.)	7.15 ..	5.26 ..	28.60 ..	23.34 ..
200 lb/acre N/A every 3 months (800 lb.)	7.22 ..	10.52 ..	28.88 ..	18.36 ..
300 lb/acre N/A every 3 months (1200 lb.)	8.78 ..	15.77 ..	35.12 ..	19.35 ..
100 lb/acre N/A every month (1200 lb.) ..	9.84 ..	15.77 ..	39.36 ..	23.59 ..
L.S.D. $P=0.05$	2.45			
$=0.01$	5.71			

The protein content varied from 5.9 per cent. for unfertilized plots to 7.2 per cent. for the highest rates of sulphate of ammonia, both figures being slightly lower than those for 1955. These figures could be used to compare costs of alternative feeds.

EXTRACT FROM AGRICULTURAL CHEMIST'S REPORT

(a) Topsoil samples were analysed shortly before the rains from the Rhodes Grass and Fertilizer Trial at Chitedze which had been treated with varying rates of nitrogenous fertilizer with and without superphosphate. The results are given in the following table.

TABLE IV
Analysis of Soil in Rhodes Grass Experiment

<i>Fertilizer application for 2 years (lb/acre)</i>	<i>pH</i>	<i>% Org. C</i>	<i>% N</i>	<i>Phosphate (p.p.m.) acid Sol. + ads.</i>
nil .. nil .. nil ..	6.55 ..	2.40 ..	.178 ..	150
nil .. nil .. 300 ..	6.70 ..	2.46 ..	.175 ..	225
600 .. nil .. nil ..	6.45 ..	2.58 ..	.177 ..	181
600 .. nil .. 300 ..	6.25 ..	2.19 ..	.170 ..	213
1200 .. nil .. nil ..	5.90 ..	2.19 ..	.170 ..	150
1200 .. nil .. 300 ..	5.80 ..	2.61 ..	.177 ..	225
nil .. 1200 .. nil ..	6.05 ..	2.40 ..	.170 ..	188
nil .. 1200 .. 300 ..	6.05 ..	2.37 ..	.170 ..	181

S/A=Sulphate of ammonia.

N/Cal.—nitro chalk.

The application of nitrogenous fertilizers appears to have had little effect on the organic carbon and nitrogen levels, but as noted in other experiments of this nature, increasing rates of sulphate of ammonia have lowered the pH quite considerably, though as might be expected the lowering of pH due to nitro-chalk is not as marked.

(b) In another fertilizer experiment on Rhodes Grass, using increasing rates of sulphate of ammonia and nitrate of soda with and without a basic dressing of superphosphate, crude protein determinations were carried out on the dried grass samples and revealed what appeared to be a depressing effect due to phosphate on the crude protein content. This was particularly noticeable where the higher rates of nitrogenous fertilizers had been applied. These figures are tabulated below.

*Total of monthly cuts period 1st August, 1955 to 31st July, 1956.

*2 Based on 1955 figures.

TABLE V
Analysis of Rhodes Grass

<i>Treatment</i>	<i>% Crude Protein</i>	<i>Reduction on protein due to P.</i>
No fertilizer	4.64	—
S/A/ 200-800 lb/acre, no P ..	4.76	mean % .. .27
S/A/ 200-800 lb/acre, with P ..	4.49	—
S/A/ 1000 lb/acre, no P ..	8.31	2.80
S/A 100 lb/acre, with P ..	5.51	—
S/A/ 1200 lb/acre, no P ..	9.28	4.64
S/A 1200 lb/acre, with P ..	4.64	—
N/S 1200 lb/acre, no P ..	7.09	1.61
N/S 1200 lb/acre, with P ..	5.43	—
S/A=Sulphate of ammonia.		N/S=Nitrate of Soda.

SMALL IMPLEMENT TRIALS

Two types of plough were used, one of English and the other of South African manufacture and there was little difference in their performance, though the former was a little easier to handle. Trials were made on Kota Kota rice lands and it was found that half an acre a day could be ploughed on the heavy soil and three-quarters of an acre on the lighter soil. All work was done with one pair of oxen and though it would have been better to have used two pairs on the heavy soil it was found that the larger number was unmanageable. Timing of operation should be chosen carefully in order that soil may have optimum moisture for ease of work. It has been found that with new land the optimum time of ploughing is just after the rains have ended followed by a second ploughing just after the next rains have begun. In the case of second year land only the second ploughing is required.

Trials were also made with two makes of ox-plough, manufactured in Southern Rhodesia. Although they were not quite so sturdy and did not handle so easily as their English counterpart, they did an efficient job when fitted with the upset type of share. They should be quite suitable for use in this country.

Trials were conducted with hand-operated groundnut shelling machines, but they were not found to be very efficient. The big variation in size of the local nut makes machine shelling difficult.

REPORT OF THE TEA RESEARCH STATION

Unless otherwise stated this report refers to the crop season July 1955 to June 1956. During the season no new formal experiments were planted on the stations and new plantings at Mimosa were confined to "squaring-off" experimental surrounds.

The only new formal experiment to be started was the "three-cubed" N.P.K. factorial fertilizer on mature tea at Namireme estate in Cholo District.

Six estates submitted seed for certification during the 1955 season and seven during 1956.

The Tea Research Committee met on two occasions and prominent amongst the decisions it made were those sponsoring a visit by the Senior Tea Research Officer to the tea areas and research stations in India and Ceylon, giving every encouragement to the Meteorological Services in setting up an observatory at Mimosa and to sponsor the appointment of a biochemist to work on the problem of fermentation in Nyasaland teas. The latter appointment was subsequently agreed to by the Nyasaland Tea Association, who are to finance the project and at the time of writing a search is being made for a suitably qualified scientist.

Climatically, the year has been a good one for crop. The total rainfall for the season was near to the long term average but the distribution of showers has been good and higher-than-average crops have been harvested. A severe and localised hail storm on 1st November severely damaged 60 per cent. of the Swazi tea acreage and must have caused loss of potential yield.

Labour was on the whole adequate throughout the season and no experiments on the stations suffered from lack of plucking or routine weeding.

Two successful Open Days were held on the 9th and 10th of April 1956 when a total of 105 people attended.

Requests for advice are increasing at a gratifying rate and it appears that the Industry is becoming more and more aware of and interested in, the facilities that its research station can offer.

Although this annual report is meant to be a progress report complete in itself, it is desirable at times to draw attention to matters in certain sections of this report and to sections in previous annual reports. The method of cross-referencing has not been easy because of the double printing in past years of our report: firstly by the Tea Association and secondly by Government. Different formats have been used which have led to similar paragraphs appearing under different page numbers in the two reports and the only way of overcoming this has been to cross-reference by using rather full and unwieldy phrases. Starting with this report, paragraphs will be numbered in sequence and this should make for tidier cross-referencing, in future.

A report on the experimental programme follows.

Nursery Experiments

(i) SIZE OF SEEDLING IN RELATIONSHIP TO SURVIVAL IN THE FIELD AFTER PLANTING

The object of growing tea seedlings in a nursery is to provide suitable plants for transplanting into a permanent field site. The success of nursery techniques must therefore be ultimately assessed by the numbers of plants from the nursery which survive transplanting.

The suitability of a seedling for transplanting from the nursery to the field is usually made by observing its diameter at four inches above soil level and discarding seedlings which have diameters less than the desired minimum which was traditionally held to be "pencil thickness" (5/16th inch).

As reported in previous annual reports, diameter and survival counts were made on the Establishment Experiments at Mimosa and the Bvumbwe* Station, and with the completion of the three successive seasonal replications it is now possible to offer a precise minimum diameter for practical use.

In all these experiments the best combination of treatments for survival has been by transplanting seedlings (as stumps) grown for thirty months in a nursery receiving fertilizer dressings, shading the collar of the stump with a pot and giving to each stump a "starter-dressing" of fertilizer shortly after transplanting. (For more detail see the section under ESTABLISHMENT EXPERIMENTS below and in past reports.)

*Note.—In previous reports the Cholo establishment experiments have been recorded as being sited at the "Tung Station". The name of this station has been changed to the "Bvumbwe Agricultural and Tung Experimental Station" and in keeping, "Bvumbwe" will replace the old name "Tung Station" in this Report.

Diameter-survival counts from this treatment combination are listed below in Table I.

Table I
Stump diameters in 1/16th inch steps and percentage survival

Station	Planting Season	Mean stump diameters in 1/16 inch steps									
		3	4	5	6	7	8	9	10	11	12 and over
Mimosa	52/53	—	95	87	90	91	96	93	96	100	100
	53/54	67	86	93	90	97	98	100	100	100	100
	54/55	70	84	90	98	100	100	100	100	100	100
Bvumbwe ..	52/53	50	62	79	88	90	94	91	95	100	100
	53/54	—	39	54	77	84	89	85	100	100	100
	54/55	71	88	93	98	100	100	100	100	100	100

Climatically the seasons in sequence can be classified as nearly average, very poor and above average. Complete survival at both stations and in every season was obtained by using stumps of 11/16 inches diameter and over.

The ideal in every new planting should be to obtain a complete stand during the first 12 months and the above table indicates that this ideal could be guaranteed in both districts under the conditions of the experiment by using stumps with diameters of not less than 11/16th inches.

Traditional nursery techniques viewed in the light of the results from the Establishment Experiments are inefficient and to insist on a minimum diameter of 11/16th inches would virtually exclude not less than nine-tenths of all seedlings grown in an average quality thirty-months-old nursery. In present day circumstances therefore interpretation of the above table in its practical aspects must remain largely arbitrary. Nevertheless a high stand must be aimed at following first planting and a target of not less than 90 per cent. is considered to be reasonable. This would be achieved with good guarantee, by using stumps of not less than 7/16 inches diameter at four inches above soil level.

For a number of seasons, counts have been made of seedling diameters in the Swazi and Mimosa nurseries and demonstrate quite clearly the inefficiency of traditional Nyasaland nursery methods. There is therefore a definite necessity for further experimental work on nursery methods. The nurseries at the Tea Research Stations are usually average to good in quality and all the data below refer to the standard nursery spacing of six by six inches square.

Table II
Percentages of stumps over 7/16th inches and 11/16th inches as taken from various sources

Planting season			Experiment	Age in months	% over 7/16th inch	% over 11/16th inch
1954/55	..	..	General nursery, Mimosa	30	50 to 60	less than 10
1952/53	..	..	Establishment	18	4.3	0.0
1953/54	..	..	„	18	3.0	0.0
1954/55	..	..	„	18	8.2	0.0
1952/53	..	..	„	30	57.7	6.1
1953/54	..	..	„	30	33.7	1.0
1954/55	..	..	„	30	33.7	0.9
1951/52	..	..	Root weights	18	3.0	0.0
1951/52	..	..	X Stem Diameters	30	42.7	3.0
1953/54	..	..	Fertilizers N.P.K.D.B.	30	44.0	0.4
1955/56	..	..	Spacing	30	69.0	8.5

Sample counts taken over a range of commercial thirty-month- old nurseries lead to the expectation of 40 to 60 per cent. of stumps being over 7/16 inches diameter.

The very low percentages for the 30-month-old 1953/54 and 1954/55 Establishment Experiments are due to these nurseries being grown on a poor site which has since been abandoned in favour of a permanent nursery area from which was obtained the more satisfactory 1955/56 spacing percentages. In these circumstances the minimum diameter recommended is therefore 7/16 inch.

Of particular importance is the proportionate increase in inter-bush competition as the number of plants per acre increases. With the closer spacings now becoming popular attention is invited to the appropriate section under SPACING EXPERIMENTS in this report.

For Cholo, (as represented by Bvumbwe) where climatic conditions are more severe than in Mlanje, the importance of not using stumps less than the recommended minimum cannot be over-emphasised and every effort should be made in practice to use stumps of not less than a half inch diameter.

(ii) NURSERY SPACING EXPERIMENT, MIMOSA

A simple spacing experiment in a randomised block design was planted in the Mimosa nurseries in 1953 and compared the growth of seedlings spaced at:

6×6 inches square			
8×8	..	..	
10×10	..	..	
12×12	..	..	

Thirty months after planting, diameter measurements were taken and the effects of treatments assessed by calculating the numbers of seedlings with diameters of 7/16 inches and over at four inches above soil level for each square yard of nursery bed used and by calculating the percentage of the total seed used which produced these plants.

Table III

Numbers of plants with diameters at 7/16 inches and over for each square yard of nursery bed used

Spacings	6"×6"	..	8"×8"	..	10"×10"	..	12"×12"
Numbers	..	22	..	15	..	12	.. 8
L.S.D.	P=0.05 = 5		P=0.01 = 8				

These data approximate to a smooth curve when plotted on a graph and indicate thereby that spacing has had a systematic effect on the number of "useful" plants produced. Closer spacing is more efficient in *land* usage than wider spacing when assessed by this measurement.

Table IV

Percentage of seed planted which produced plants at 7/16 inches diameter and over

Spacing	6"×6"	..	8"×8"	..	10"×10"	..	12"×12"
Percentages	..	62	..	74	..	91	.. 93

As can be expected these data also approximate to a smooth curve when graphed and from this table it can be seen that wider spacing is more efficient in *seed* usage.

The results of this experiment indicate that where land area is the prime concern and seed of secondary concern, the most efficient use of nursery land will be obtained by using closer spacings. Where however seed supplies and not land is the main consideration then wider spacing should be used.

(i) ESTABLISHMENT EXPERIMENT, MIMOSA AND TUNG STATION

The third and final replications of these experiments were planted at Mimosa and Bvumbwe (Tung Station) in December 1954. Survival counts were taken in December 1955 and pruning weights as an indicator of early growth, in May 1956.

Treatments at Mimosa were as in last year's report:

- (a) 18-month-old stumps against 30-month-old stumps.
- (b) no nursery fertilizer against 2 ozs. of fertilizer mixture (6:10:8) per square yard of nursery bed.
- (c) stumps shaded with earthenware collar pots against shading with fish bean (*Tephrosia vogelii*).
- (d) no "starter" fertilizer against 1 ounce fertilizer mixture (6:10:8) applied near to the stump, immediately after planting.

At the Bvumbwe Station the treatments were designed to be identical with those at Mimosa but the *Tephrosia* would not grow well despite its being supplied four times with similar seed as compared with Mimosa where it grew without trouble. In these circumstances treatment (c) at Bvumbwe virtually became a comparison between collar pots and no shade.

Tables V and VI record percentages of deaths and fresh weights of prunings according to treatments.

Table V
Percentage deaths twelve months after planting out, of the numbers of stumps originally planted

				Age (a)		Nursery Fert. (b)		Shade (c)		Starter fert. (d)	
				18 m.	30 m.	—	+	Pots	Teph.	—	+
Mimosa	..	..	..	7.6	7.0	6.9	7.7	5.2	9.4	7.0	7.6
Bvumbwe	..	..	..	21.8	13.3	18.6	16.5	13.5	21.6	15.1	20.0

L.S.D. Mimosa; $P=0.05 = \text{none}$

Bvumbwe; $P=0.05 = 6.4$; $P=0.01 = \text{none}$

The weather following the planting of these replications was very good and at both stations the percentage of deaths is the lowest for any of the three seasons used in these experiments. At Mimosa no significant differences exist between treatments effects although *Tephrosia vogelii* as in previous seasons, has caused the highest numbers of deaths. At Bvumbwe 30-month-old stumps had significantly less deaths than 18-month-old stumps, and no shade (which should have been *Tephrosia* shade had it grown) caused significantly more deaths than stumps shaded with pots confirming thereby Leach's observations made as early as 1935.

Table VI
Total weight of prunings obtained in lb. fresh weight

				Age (a)		Nursery fert. (b)		Shade (c)		Starter fert. (d)	
				18 m.	30 m.	—	+	pots	Teph.	—	+
Mimosa	..	..	..	572	845	717	700	1,060	357	700	717
Bvumbwe	..	..	..	56	116	90	82	96	76	86	86

L.S.D. Mimosa;	P=0.05 = 129	P=0.01 = 176	
L.S.D. Bvumbwe;	P=0.05 = 48	P=0.01 = none	

The total weight of growth harvested at Mimosa was 8.2 times heavier than that at Bvumbwe, both replications being pruned to a standard height of ten inches above soil level. At Mimosa 30-month-old stumps have significantly out-yielded the 18-month-old stumps and *Tephrosia*, as always, has significantly reduced growth against stumps shaded with pots. At Bvumbwe 30-month-old stumps have out-yielded the younger stumps, there being no other significant differences.

It is hoped in due course to publish the entire results of this experiment elsewhere, but in the meantime the following summary of the main conclusions and recommended practical methods can be given:

(a) The minimum stump diameter that should be planted is 7/16 inch at four inches above soil level.

(b) This diameter was most efficiently produced in this experiment by growing seedlings for 30 months in the nursery and spaced at 6 x 6 inches square. (But see the section above under NURSERY EXPERIMENTS.)

(c) The nurseries receiving fertilizer dressings of 2 ozs. per square yard of a 6:10:8 mixture were more efficient than those with no fertilizer. (The exact requirements of nursery fertilizer under varying soil types and conditions are not known and the mixture quoted here is the one used in this experiment. See Annual Reports for 1952/53, 1953/54 and 1954/55, sections on NURSERY EXPERIMENTS.)

(d) Immediately after planting, stumps should have their collars shaded with pots.

(e) Fish bean should not be used as a cover crop or shade. (Other observation and experiments in Nyasaland have shown Pigeon Pea (*Cajanus cajan*) and other heavy cover crops to be detrimental.)

(f) One ounce of a 6:10:8 fertilizer mixture per plant was beneficial when given shortly after planting and placed near to the stump. (In other experiments a minimum of half an ounce per plant of sulphate of ammonia was effective in warding off sulphur deficiency "yellows" and no benefits in survival have been obtained in the first 18 months of growth from nitrogen phosphate or potash dressings when sulphur has been adequate.)

(ii) THE EFFECT OF VARIOUS SPACINGS ON THE SURVIVAL OF NEWLY-PLANTED TEA

Three successive replications of the "Complex" experiment were planted in three successive years starting with December 1952. For the second and third replications planted in 1953 and 1954 respectively, counts were made of the numbers of deaths approximately 12 months after planting. Unfortunately no counts were taken at this stage for the first replication. Thereafter at twelve monthly intervals counts have been made of the number of replants per plot for each replication. Details of counts by spacing treatments are given in Table VII.

Table VII
Percentage of replants according to spacing and age after planting

Count taken at	Replication	Spacing	4' x 4'	4' x 3'	4' x (2' x 2')	L.S.D.	
		plants p.a.	2720	3630	7260	P0.05	P0.01
12 months	I	no counts taken				—	—
	II		3.4	2.7	2.8	none	—
	III		5.0	4.6	4.6	none	—
24 months	I		3.6	3.6	6.9	0.9	1.2
	II		1.4	1.6	2.6	0.6	0.9
36 months	I		2.6	3.0	4.5	1.2	1.6

During the first 12 months after planting there were no significant differences in percentage deaths caused by spacing treatments but thereafter significant differences appeared and the closely spaced hedge planted tea had a significantly greater percentage of deaths than the two wider spacings. There being no significant differences between these latter.

Increasing nitrogen rates, which form another set of treatments in this experiment, have had no significant effects on survival but it should be noted that sulphur is equalised over all plots by additions of flowers of sulphur as necessitated by the treatment rate. Experience so far in these and other experiments indirectly suggests that it is sulphur which is beneficial in the early years and not any of the three major nutrients as such.

These results suggest that competition between closely spaced plants becomes evident during the second year after planting; a conclusion supported by pruning weights, tea yields and by the root studies described in later sections of this report. It follows therefrom that every effort must be made to establish a complete stand during the first planting season. Supplies will be more difficult to establish in the closer spacings and this is of distinct practical importance with the present tendency of the industry to use closer spacings than the traditional 4 × 4 feet square.

The comparatively high percentages of the first year counts for replication III are due primarily to the effects of one block which has fallen on a soil area of unusually low fertility.

Root Studies

DEVELOPMENT OF THE ROOT SYSTEM, SWAZI

As reported in previous Annual Reports qualitative and rather crude studies are being made at intervals on the development of the new root system after planting stumps into the field. The plants under investigation were transplanted from the nursery in December 1952 and field spacing is four feet square.

The latest root-washings to be made were in May 1956, or approximately three-and-a-half years after transplanting and the following notes were recorded at this stage.

The top two feet of soil volume is well colonised by a branching system of woody laterals bearing masses of fine succulent feeding roots. The thicknesses and quantities of the woody laterals vary considerably between plants, some having little more than a few lignified supporters for their fine feeding roots whereas others bear up to seven well developed laterals with diameters up to a half inch diameter at their junction with the main tap root. In all the plants examined, the lateral penetration into the top foot of soil volume between plants was complete; at a distance of approximately half way between plants and for an overlap of about one foot, there was considerable inter-mingling of laterals and fine feeders from adjacent plants. Occasional laterals were seen to have spread beyond this range and in one case the lateral from one bush had grown out beyond its neighbour.

Penetration in depth of "tap" roots was variable between plants, being not less than three feet and not more than six feet. The number of deeply penetrating roots was variable between plants, ranging from one to three per plant. Unlike the lateral spreading roots the diameters of the tap roots where they adjoin the stump were fairly constant and near to one quarter of an inch. There is a gradual decrease in diameter with depth and at the maximum depth the root is succulent bearing a cone of roots similar to the fine feeders of the surface lateral system.

One undoubted fact obtained in these studies is that root competition between plants is evident. An impression was obtained within the small sample examined that there appeared to be two morphological forms of rooting systems. Where there was strong lateral development, penetration in depth appeared to be lost and *vice versa*. It must be emphasised that this is only an impression; to investigate the matter fully would require careful measurements from large samples, it being apparent that considerable variability exists between plants.

Pruning Experiments

(i) LENGTH OF PRUNING CYCLE AND TYPE OF PRUNE, SWAZI

This experiment on poor Indian jat tea completed its fifth successive three-year pruning cycle in June 1956 and compares the following treatments:—

Clean prune every year,

Clean prune every second year,

Clean prune every third year.

Cut-across prune every year with no cleaning out,

Cut-across prune every second year with no cleaning out,

Cut-across prune every year with cleaning out of centres.

Yields for the past three seasons are given in Table VIII.

Table VIII

Effect on yields in lb. m.t.p.a., of pruning type and length of pruning cycle for the three seasons 1953/54 to 1955/56

Yearly	Clean prune			Cut across prune			L.S.D. P=0.05
	2 yearly	3 yearly	Yearly	2 yearly	Centring		
2,505	2,849	2,841	2,652	3,157	2,671	383	

During this period the annually pruned plots received three prunings; the two yearly plots, two prunes and the three yearly plots, one prune. The highest yield has been given by the two yearly cut-across treatment which has yielded significantly more crop than any of the annually pruned plots. There are no other significant differences.

Over the 15 seasons that this experiment has had continuous treatments the total yields are:

Table IX

Cumulative effect on yields in lb. m.t.p.a., of pruning type and length of pruning cycle for 15 successive years

				Clean prune			Cut-across prune		
				Yearly	2 yearly	3 yearly	Yearly	2 yearly	Centring
Yield	..	..	..	16,373	18,095	17,662	16,683	17,216	16,471
Order of merit	..	..	..	6th	1st	2nd	4th	3rd	5th

The design of this early experiment is not adequate to enable these results to be firmly interpreted. The over-riding fault is that all plots of any one treatment reach their pruning date in the same season. As response from pruning varies within any cycle with length of time from the prune and with climate of a season there is always an alternative bias with one or other of the extended cycles and in these circumstances it has not been possible to lay down firm quantitative conclusions applicable to any year in the experiment's history. (On estate scale operations, each year a proportionate area of tea is pruned to fit with the pruning cycle as a whole. Thus on a two year cycle, approximately half of the tea would be or should be pruned each year.) This difficulty has to a certain extent been anticipated for the proposed pruning cycles in the Complex Experiments.

Nevertheless the conclusions drawn previously are upheld; in the early years short cycles are best but as the tea matures longer cycles are better. The detrimental consequences of too frequently denuding the bush of leaf and not preserving adequate maintenance leaf in the top hamper have been demonstrated by Tubbs and Eden in Ceylon.

It is of great interest to note from Tables VIII and IX that the two yearly cut-across cycle holds an honourable place, yet the mass of twigs, living and dead, within the top hamper is entirely opposite to orthodox concepts of "tidy" pruning.

The frame works of the annually pruned bushes are so thin and poor that a reluctant decision has been made to down-prune as a starting point towards building new frames. There is so little leaf in the top hamper that the plots have been thrown out of plucking for a period before the heavy prune. The two yearly plots have not been down-pruned in their history to-date but are now requiring a heavy prune (the annual plots had a light down-prune in 1952). They too will be rested for some months before being heavily pruned in 1957. The three yearly cycle plots are not yet in need of this drastic treatment.

(ii) PRUNING CYCLE ON LOCAL JAT TEA, THORNWOOD ESTATE

One set of treatments within the three-cubed factorial experiment on local jat (hybrid) tea is the comparison of clean pruning on one, two and three yearly cycles. At the start of the 1955/56 season the annual and three yearly plots were pruned; the two yearly plots being unpruned and in their second year from prune. All plots were pruned at the start of the experiment during the 1952/53 season.

Yields in lbs. of made tea per acre for the past season and for the four years of the experiment according to pruning treatments are given in Table X.

Table X
Yield in lb. m.t.p.a. due to pruning cycles, Thornwood local experiment

Cycle			Yearly	2 yearly	3 yearly	L.S.D., P=	
						0.05	0.01
1955/56	..	..	1,209	1,037	1,467	105	143
4 seasons	..	..	4,520	4,127	4,410	none	none

During the past season the newly-pruned three year cycle has significantly out-yielded the annual cycle ($P=0.01$) which in turn has significantly out-yielded the unpruned two yearly cycle ($P=0.01$).

This experiment suffers from the same deficiency in design as the one reported in the previous section. Consequently it is too early to give firm recommendations from only four years' readings but the data in the last line of Table X indicate that no significant loss in crop has so far resulted from increasing the cycle beyond the one year one which is the commonest cycle used with local tea in commerce.

Tipping Experiments

(i) HEIGHT OF TIPPING INDIAN JAT TEA, SWAZI

This experiment comparing tipping heights at 4, 6 and 8 inches above the pruning cut was in its third and last year from prune. Yields in pounds of made tea per acre for this season are given in Table XI

Table XI

Yields in lb. m.t.p.a. according to tipping height in the third year from prune

Tipping ..	4"	..	6"	..	8"	..	L. S. D.
Yield ..	1,173	..	1,185	..	1,256	..	none

No significant differences appear due to tipping heights and in the two consecutive three year cycles that this experiment has run, increasing heights of tip have only caused significant losses in crop in the actual tipping periods following the two prunes and before plucking proper commenced. In neither cycle were these significant "tipping-phase" losses carried over with significant effect into the main seasonal crops.

(ii) TIPPING LOCAL JAT TEA, THORNWOOD ESTATE

Superimposed on the three pruning cycle treatments for this experiment already described are three treatments comparing the effects of tipping at 2, 4 and 6 inches above the pruning cut. The tipping heights only apply to the one and three yearly cycles for this season; the two yearly plots being unpruned. Yields in pounds of made tea per acre are recorded in Table XII and are divided into tipping-phase yields (from August to the end of November 1955) and into whole season yields.

Table XII

Effect of tipping heights on yields in lb. m.t.p.a.

				<i>Tipping phase</i>			<i>Whole season</i>		
				2"	4"	6"	2"	4"	6"
Yearly cycle	..	..	..	107	107	95	1,244	1,238	1,145
2 yearly	..	..	..	86	78	66	1,105	991	1,014
3 yearly	..	..	..	193	158	127	1,549	1,460	1,393
Mean	..	..	..	129	114	96	1,299	1,230	1,184
				L.S.D. main effect tipping		P=0.05=26 P=0.01=35	No significant differences due to tipping heights.		

As in previous years, with this and other experiments, the only significant losses in crop have been during the tipping-phase. These early significant losses are not maintained significantly throughout the whole crop season.

(iii) EFFECT OF TIPPING HEIGHT ON NEW WOOD GROWTH, THORNWOOD EXPERIMENT

In the 1952/53 and 1953/54 reports definite statements were made that increasing tipping heights resulted in bigger and stronger wood formation within the bush frame work. In last year's report the same conclusion was drawn but a proviso was added that the cumulative effects of nitrogen treatments were making purely optical assessment of wood growth more difficult. After the prune at the

end of the 1955/56 season an attempt to assess wood growth was made as usual but it was found to be extremely difficult to give marks on estimation by eye alone. An attempt will be made to take some form of quantitative measurement in two years time when all plots are due for prune

Plucking Experiment

This experiment, reported upon in previous reports and comparing plucking on rounds of 6, 10 and 14 days intervals was discontinued at the end of the 1954/55 season.

The main conclusions are that maximum yields and the best quality leaf are obtained by plucking on as short rounds as possible, consistent with the state of development of the flush.

Fertilizer Experiments

In keeping with previous Annual Reports, this section will only deal with fertilizers applied to unshaded tea, spaced at four feet square. The interplay of fertilizers with spacing or with shade will be discussed in later sections of this report.

(i) N.P.K. EXPERIMENT ON YOUNG INDIAN TEA, MIMOSA

This experiment was planted at Mimosa in December, 1953 with stumps grown under experimental fertilizer treatments at Swazi. A description and results of the nursery fertilizer experiment have been given in the Annual Reports for 1952/53 and 1953/54. Residual fertilizer effects from the nursery or fertilizers applied to the field during the first year after planting in the field, had no significant effects on survival.

The fertilizer treatments are designed to increase yearly until the full rates are reached at seven years after planting in the field. Sulphur rates are equalized over all treatment combinations. Tables XIII (a) and (b) summarize the field treatments and fertilizers so far given.

Table XIII

(a) Summary of field treatments

<i>Date</i>	<i>Treatment</i>
Dec., 1953	Tea planted
March, 1955	First prune at 12 inches. Tipped 27"
May, 1956	Second prune at 16 inches. Tipped 27"
Dec., 1953 to June, 1955	No plucking
July, 1955 to May, 1956 ..	Light plucking

(b) Fertilizers; nutrients expressed in lb. p.a. of N, P₂O₅, or K₂O

<i>Date given</i>	<i>Nutrients lb. p.a.</i>					
	<i>n0</i>	<i>n1</i>	<i>p0</i>	<i>p1</i>	<i>k0</i>	<i>k1</i>
June, 1954	10	20	nil	10	nil	20
Dec., 1954	15	30	nil	10	nil	20
Nov., 1955	20	40	nil	15	nil	20

First yields were taken from light plucking during the 1955/1956 season and are recorded in Table XIV. Fertilizers used are sulphate of ammonia, super-phosphate and muriate of potash; sulphur being equalized by adding flowers of sulphur as necessary to all treatment combinations.

Table XIV

Yields from July, 1955 to May, 1956 in lb. m.t.p.a. according to fertilizer treatments on young Indian jat tea

Treatment	n0	n1	p0	p1	k0	k1
Yield m.t. p.a.	253	264	258	259	262	255

There are no significant differences in yield due to treatments and the conclusion expressed in previous reports, that young tea cannot efficiently use large amounts of fertilizer providing sulphur is adequate, is further strengthened. It appears indirectly from this and allied experiments that the responses obtained from sulphate of ammonia in the very early years are primarily due to the beneficial effects of its sulphur content and not to nitrogen *per se*. When sulphur is equalized over all plots, as in this experiment, then no apparent responses are obtained from sulphate of ammonia.

(From data on the minimum sulphur rates see the Annual Report for 1953/54 under SPACING EXPERIMENTS).

(ii) SULPHATE OF AMMONIA AT FOUR RATES ON TEN YEAR OLD INDIAN TEA, SWAZI

This tea, planted in 1946, was in its second season from prune and received its sixth year of fertilizer treatments which are; 0, 80, 160, 240 lb. of nitrogen (N) per acre applied as sulphate of ammonia. All plots received an equal dressing of P_2O_5 and K_2O .

Yields for the past season are recorded in Table XV.

Table XV

Effect of increasing sulphate of ammonia rates on the yields of ten year old tea

lb. N. p.a.	0	80	160	240
Yield lb. m.t. p.a.	1,306	1,751	1,835	1,967
L.S.D.	P=0.05 = 153 P=0.01 = 212 P=0.001 = 293			

All rates of sulphate of ammonia have significantly out-yielded the control ($P=0.001$). The difference between n240 and n80 is significant at $P=0.01$, there being no significant differences between n80 and n160 or n160 and n240. The return in lbs. of made tea for each lb. of nitrogen applied is 5.56 for the first 80; 1.05 for the second 80 and 1.65 from n160 to n240.

From these data it would appear that a dressing of 80 lbs. of nitrogen per acre as sulphate of ammonia is the economic upper limit for ten year old tea, spaced at 4×4 feet square.

(iii) SULPHATE OF AMMONIA AT FOUR RATES ON MATURE INDIAN TEA, SWAZI

This tea, 23 years old, was in its second year from prune. From 1947/48 until 1953/54 the treatments were 0, 35, 52 and 70 lbs. of nitrogen per acre as sulphate of ammonia. From the 1954/55 season the previous no fertilizer control plots received 120 lbs. of nitrogen per acre, the other rates remaining unaltered. All plots received equal dressings of P_2O_5 and K_2O . Yields for the past season, the second season of the n120 treatment are given in Table XVI.

Table XVI
Effect of four sulphate of ammonia rates on the yield of 23 year old tea

<i>lb. N. p.a.</i>	35	52	70	120	P=0.05	P=0.01
Yield lb. m.t. p.a. ..	652	708	922	896	132	180

At P=0.01, the two highest rates of nitrogen have significantly out-yielded the two lower, there being no significant differences within either pair at P=0.05. Each lb. of nitrogen between n35 and n70 returned 7.71 lbs. of made tea.

Recovery in yield was rapid after the highest rate was applied to the previously no fertilizer control plots, and this can be seen in Table XVII.

Table XVII
Recovery in yield of the control plots after receiving fertilizer

				<i>lb. m.t. p.a.</i>			<i>Yields as % of n35</i>		
Treatment	..	..	..	no	n35	n70	no	n35	n70
1952/53	..	..	..	257	443	565	58	100	128
1953/54	..	..	..	134	247	337	54	100	136
Treatment	..	..	..	n120	n35	n70	n120	n35	n70
1954/55	..	..	..	767	818	1,006	94	100	123
1955/56	..	..	..	896	652	922	137	100	141

Full recovery of yield might possibly be obtained next season, the third after the fertilizer was first added to the control plots.

(iv) **THREE-CUBED FACTORIAL N.P.K. ON MATURE INDIAN TEA, SWAZI**

This experiment received its fifth consecutive set of treatments during the past season. The tea is 24 years old, planted at four by four feet square and unshaded.

Throughout this past season this experiment has suffered considerable maltreatment which has reduced yields with a resulting high standard error equal to 19 per cent. of the mean yield, being thereby twice the usual value. One complete replication was heavily down-pruned towards the end of the previous season and as it turned out the operation was carried out too late, resulting in a serious delay in recovery from prune. At the start of the rains an extremely severe hail storm heavily damaged the succulent new shoots following this prune. The lesson of the deleterious effects of late down-pruning was learned and the second replication was therefore down-pruned during the main rains and half way through the present crop season, causing a loss of potential crop which would have been credited to the seasonal yields had a normal clean prune been given at the usual time. Yields in lbs. of made tea per acre for the season are recorded in Table XVIII.

Table XVIII
Effect of N.P.K. on yields at Swazi

<i>Nutrient</i>				N.			P ₂ O ₅			K ₂ O		
Lb. p.a.	..	..	..	40	80	120	0	30	60	0	30	60
Yield m.t.	..	..	..	319	455	571	436	425	484	448	462	435
L.S.D.	..	..	..	P=0.001 = 109			none			none		

Each upward step in nitrogen has caused highly reliable increases in crop, the return in made tea for each lb. of nitrogen added being 3.4 from n40 to n80 and 2.9 from n80 to n120. These returns are much lower than those obtained from comparative Mlanje experiments this season and must be regarded as being abnormal in view of the unfortunate seasonal history of this experiment.

The responses to phosphate are not significant, but the analysis of variance for this season indicates that the gap is widening and a more exciting result may possibly be obtained during the next season.

Potash has caused no significant differences in yield.

(v) SULPHATE OF AMMONIA ON LOCAL JAT TEA, THORNWOOD EXPERIMENT

In addition to the length of pruning cycle and height of tipping treatments already described, this experiment compares the effects of sulphate of ammonia supplying the equivalents of 40, 80 and 120 lbs. of nitrogen per acre.

Yields for the past season are given in Table XIX.

Table XIX

Effect of increasing nitrogen rates on the yields of local jat tea, at Thornwood

<i>Lb. N. p.a.</i>	40	80	120	L.S.D. <i>P</i> =0.001
Yield	929	1,239	1,545	192

Increasing nitrogen rates have caused highly reliable and linear increases in yield; the return in made tea for each lb. of nitrogen added averages, over all other treatments, 7.8 lbs. from n40 to n80 and 7.6 lbs. from n80 to n120.

In previous reports it has been stated that the proportionate return from nitrogen is greater in unpruned years than in pruned years. The present season's data, as recorded in Table XX below, refute this statement. It is strongly suspected from negative evidence, that responses to nitrogen and pruning are bound up with the season's climate but as no method has yet been found of assessing climatic effects either alone, or in combination with field management practices, no explanation can be offered for this season's result being opposed to previous experience. There appears to be little doubt that climatically this season was curious. The usual measure of "climate" is taken as total seasonal rainfall, which in spite of its universal use is a demonstrably bad unit. The total rainfall for the season was very near to the ten year mean and a considerable proportion of this total fell later in the season than usual. Nevertheless, judging by the record crops harvested by the industry, the seasonal climate was most efficient and far more so than a comparison between the season's rainfall and the ten year mean would indicate.

Table XX

Response in lb. m.t. for each lb. of nitrogen added, Thornwood experiment

	<i>From n40 to n80</i>	<i>From n80 to n120</i>	<i>mean</i>
Yearly cycle, pruned	7.0	7.7	7.4
2 yearly cycle, unpruned	7.1	7.8	7.5
3 yearly cycle, pruned	9.1	7.5	8.3
Mean of all cycles	7.8	7.7	

(vi) THREE CUBED FACTORIAL N.P.K. ON MATURE INDIAN TEA, NAMIREME ESTATE, CHOLO

A uniformity trial was carried out for this experiment during the 1954/55 season and fertilizer treatments were first applied in November, 1955, in preparation for the 1955/56 crop season. The tea, spaced at four feet square and unshaded, was planted in 1940 on soil which had previously held tobacco or food crops without rejuvenation before planting to tea.

Soil analysis at the start of the present experiment describes the soils as having low to marginal organic matter and nitrogen status, with unusually low phosphate reserves and marginal potash. The base saturation percentages together with acidity values in the range of pH 5.3 to 5.7, show the soils to be highly leached.

The fertilizer rates used are replicas of those used in the Swazi experiment. A breakdown in communications on two occasions caused two plucking rounds to be missed. Recorded yields for the past season are given in Table XXI.

Table XXI
Effect of N.P.K. on yields at Namirembe estate

Nutrient			N			P ₂ O ₅			K ₂ O		
Lb. p.a. . .	..	..	40	80	120	0	30	60	0	30	60
Yield m.t. p.a.	..	..	443	519	571	524	510	499	493	519	521
L.S.D.	..	..	P=0.05=55			none			none		

The only significant difference to be recorded after this first season of treatments is that between n40 and n80. The increase in yield from n80 to n120 misses significance at P=0.05 by only 3 lb. of made tea per acre.

No further comment will be made at this early stage in the life of this experiment.

(vii) VARIABILITY OF NITROGEN RESPONSES

From the above experiments the calculated returns in pounds of made tea for each pound of added nitrogen vary from 3.3 to 7.8. This variability is not peculiar to this season and presents a problem which cannot be satisfactorily answered with our present state of knowledge. Abortive analyses of past data suggest that the answer will lie, at its simplest, in the relationship between the seasonal rainfall and its ability to maintain optimum soil moisture reserves. This is not likely to be an obviously straightforward problem because for example, the length of pruning cycle and its consequent increase in transpirational potential will affect soil moisture requirements by itself; nitrogen again is known to increase the density of leaf and hence transpirational potential. Nothing is known of pruning effects or fertilizer effects on root activity. A consideration of the possible effects of these two management methods alone and in combination will indicate their possible complex effects on soil moisture requirements and from thence to rainfall requirements. Virtually nothing of importance is known about soil moisture under Nyasaland tea. (One distressing fact is quite clear and is of no help whatsoever—Nyasaland's rainfall is very very variable). Observations on soil moisture are to start as soon as equipment is received.

No response has been calculated for the Namirembe factorial experiment, this being the first season of fertilizer treatments. The responses from the Swazi factorial experiment must be regarded as abnormal in view of the seasonal history of the trial. The two remaining experiments dealing with old tea gave responses of 7.7, 7.8 and 7.7 pounds of tea and these returns must be regarded as near to the true response for tea grown under the conditions of those experiments. The older of these two experiments gives a long term average of 4.5 lb. of made tea for each added pound of nitrogen and in comparison the present season is therefore good. The return of 5.6 pounds of made tea obtained from the first 80 pounds of nitrogen added to the experiment using ten year old tea (*i.e.*, just reaching maturity) is the highest response so far obtained and taking into account the comparatively young age of this tea the response must be considered as high, supporting the previously held conclusion that this has been a good season.

(viii) NITROGEN OR SULPHUR EXPERIMENT, SWAZI

There are no significant differences showing in this experiment.

Time of Fertilizer Application

(i) AT FOUR TIMES DURING THE MAIN CROP SEASON, SWAZI

This experiment continued and compares the equivalent of 80 pounds of nitrogen per acre as sulphate of ammonia applied in whole or split doses during the main cropping season. There are four times of application:—

- N. Whole application during the first week of November.
- $\frac{1}{2}$ N. $\frac{1}{2}$ J. Half application during the first week of November and remaining half during the first week in January.
- J. Whole application during the first week of January.
- $\frac{1}{2}$ N. $\frac{1}{2}$ M. Half application during the first week of November and remaining hal. during the first week of March.

There are no formal significant differences between treatments for reasons described in the 1953/54 Annual Report, and this season's yields recorded in Table XXII bear out previous results in that of the four times examined the most efficient is a whole dressing applied during the first week of November.

Table XXII

Yields from four times of applying sulphate of ammonia expressed as a percentage of the whole November treatment

<i>Time of Application</i>					<i>Per cent. Crop</i>
N.	..	..	..	..	100.0
$\frac{1}{2}$ N. $\frac{1}{2}$ J.	..	..	..	..	95.3
J.	..	..	..	..	92.6
$\frac{1}{2}$ N. $\frac{1}{2}$ M.	..	..	..	..	93.7

(ii) MID DRY SEASON AGAINST EARLY CROP SEASON DRESSINGS, SWAZI

Two times of fertilizer application are superimposed on the four rates of sulphate of ammonia experiment on mature Indian jat tea at Swazi which was described above. For the fourth successive season a significant loss in crop was occasioned by applying fertilizer at the beginning of July in comparison with the same amounts applied in the first week of November.

Table XXIII

Effect of July and November dressings of sulphate of ammonia recorded as a percentage of the November yield

<i>Applied</i>				<i>July</i>	<i>November</i>
Yield 1955/56	..	..	..	89.6	100.0
L.S.D. P—0.01	..	..	..	7.7	

(iii) THREE TIMES OF APPLICATION, SWAZI

Superimposed on the three heights of tipping experiment at Swazi is three times of applying fertilizer. As described in last year's Annual Report these later treatments compare whole applications applied in the first week of November, of September and of January. This is the second season of these comparisons. The differences recorded are not significant but support the conclusion that an early November dressing is the most efficient.

Table XXIV

Effects of applying fertilizer in September, November and January

<i>Application</i>						<i>Percentage Crop</i>
September	..	..	..	..	..	92.5
November	..	..	..	..	..	100.0
January	..	..	..	..	..	94.5

Weeds and Weeding

(i) WEED-KILLERS

Of concern, particularly in the Cholo tea areas, is the heavy weed growth which very rapidly overwhelms newly planted or young tea during the early rains: a time when the potential labour supply is still cultivating its village gardens. During this time the first of the heavy leaf flushes is in full growth and the decision has to be made whether or not to use inadequate labour forces on weeding young tea or on plucking mature tea.

Consequently some preliminary observations were started with weed-killers and these will be continued during the coming season. These early observations indicated that strong weed growth once started could not be controlled without detriment to the tea and new observations will aim at pre-emergence and post-emergence spraying with the hope of checking weed growth until mid-January at least, after which time labour is usually returning to the estates.

(ii) EFFECTS OF N.P.K. ON WEED GROWTH

The three cubed factorial N.P.K. fertilizer experiment at Swazi has been used to give information on weed growth in response to fertilizers. For the months of November and December the plots were left unweeded and thereafter an attempt was made to cut off at soil level and weigh all weed growth (grasses and softwoods) plot by plot. This is a crude method and leads to high experimental errors. Each of the two replications of this experiment has now completed a full three year pruning cycle and total weed weights are shown in Table XXV.

Before experimental weeding, normal weeding took place as required. At each weeding, weeds were left *in situ* to avoid transference of nutrients between adjacent plots.

Table XXV

Effects of N.P.K. on total fresh weights p.a. of weed growth in relationship to time from prune

<i>Nutrient</i>		N			P ₂ O ₅			K ₂ O			L.S.D.
Lb. p.a.		40	80	120	0	30	60	0	30	60	P=0.05
1st year	..	1,198	1,361	1,399	1,034	1,412	1,584	1,445	1,064	1,529	434
2nd year	..	1,133	942	889	895	963	1,106	1,000	886	1,076	none
3rd year	..	497	434	236	318	391	457	377	397	394	174

Because of large experimental errors the differences required for significance are high.

In the first year after prune the highest phosphate rate caused a significantly greater weight of weeds than the no phosphate application. There are no significant differences due to nitrogen or potash dressings.

In the second year after prune there are no significant differences due to treatments.

In the third and last year from prune the two lower rates of nitrogen have out-yielded the highest rate; there being no significant differences due to phosphate or potash dressings.

Following prune, increasing nitrogen rates caused increased weed growth but as the pruning cycle progressed these effects were reversed and weed growth was suppressed. Increasing phosphate rates caused increased weed growth throughout the cycle. Potash dressings have not affected weed growth to any obvious extent.

Spacing of Tea

(i) FOUR SPACINGS AND FOUR RATES OF SULPHATE OF AMMONIA, MIMOSA

Two replications of this experiment were planted in December 1951 and a third 12 months later. Four spacings and four rates of sulphate of ammonia are compared in all possible combinations. Treatment details applicable to the second season of yield recordings are listed below and the tea at this stage was the equivalent of three and a half years old from planting in the field at the beginning of the season. Sulphur is evened out over all plots by the additions of flowers of sulphur as required.

<i>Spacings</i>	<i>Nitrogen p.a. rates</i>
4' × 4' square planted	40 lbs. N.p.a. as S/Am.
4' × 3' " "	80 " " " "
5' × (2½' × 2½') hedge planted	160 " " " "
4' × (2' × 2') hedge planted	240 " " " "

Nitrogen effects are listed in Table XXVI.

Table XXVI

Effect of increasing nitrogen rates on the yields of tea three and a half years old

N. per acre	40	80	160	240	L.S.D.
Yield lb. m.t.p.a.	.. 417	.. 431	.. 441	.. 448	.. P=0.05=36

N, significant differences exist between nitrogen rates and bear out the contention previously mentioned that young tea cannot, providing sulphur is adequate, efficiently use large quantities of nitrogen.

The effect from increasing the numbers of plants per acre has caused significant differences in yield as can be seen from Table XXVII.

Table XXVII

Effects of increasing the number of plants per acre on the yields of tea three and a half years old

Spacing		4' × 4'		4' × 3'		5' × (2½' × 2½')		4' × (2' × 2')
Bushes per acre	..	2,720	..	3,630	..	4,650	..	7,260
Yield lb. m.t. per acre	..	357	..	425	..	447	..	508
	L.S.D.	P = 0.05 = 36						
		P = 0.01 = 49						

At $P=0.01$, hedge planted tea spaced at $4' \times (2' \times 2')$ has significantly out-yielded all the other spacings. At the same level of probability hedge planted tea spaced at $5' \times (2\frac{1}{2}' \times 2\frac{1}{2}')$ has not significantly outyielded tea spaced at $4' \times 3'$ square but both these spacings have significantly yielded more than the standard $4' \times 4'$ square spacing.

There are no significant interactions between spacing and nitrogen rates.

An analysis of mean bush yields shows that nitrogen caused no significant differences in yield but that increasing the numbers of plants per acre significantly decreased mean bush yields between spacings. At $P=0.01$ the two wider spacings showed no significant differences in mean bush yield but both outyielded the $5' \times (2\frac{1}{2}' \times 2\frac{1}{2}')$ hedge planted which in turn outyielded the $4' \times (2' \times 2')$ hedge planted. These data when read in conjunction with the total yields per acre substantiate the hypothesis reported under the section on establishing tea in the field, that inter-bush competition sets in at an early age. The loss in mean bush yield is outweighed by increasing the total numbers of bushes per acre and the total yield per acre is consequently increased.

(ii) ' COMPLEX ' EXPERIMENT, MIMOSA

Mention has been made in the sections under PRUNING EXPERIMENTS of the difficulties experienced in interpreting experimental data because of wide inter- and intra-seasonal variations in climate. No method has been discovered of accounting in a precise manner for seasonal effects.

In a direct method of attack on this problem one experiment, called for brevity " the Complex ", has been planted in three stages. There are three complete replications and each was planted in three successive seasons, starting at December 1952. The second followed in December 1953 and the third in November 1954.

When the tea is mature it is intended to compare the following sets of treatments, each being at three levels:

- Different spacings,
- Different nitrogen rates,
- Different lengths of pruning cycles,
- Different times of pruning.

Until the tea is mature only spacings and nitrogen rates are being compared, the latter increasing yearly until the mature rates are applied at four years after planting in the field.

(a) Spacings

- 4' × 4' square planted, equalling 2,720 bushes per acre,
- 4' × 3' rectangular planted, equalling 3,630 bushes per acre,
- 4' × (2' × 2') hedge planted, equalling 7,260 bushes per acre.

(b) *Nitrogen (N.) rates per acre*

First year	..	10	20	30
2nd year	..	20	40	60
3rd year ..	..	30	60	90
4th year ..	..	40	80	120
5th year	..	40	80	120

Thereafter to continue as for fifth year.

Note. Sulphur will be equalised over all plots until the sixth year.

Under the sections on ESTABLISHMENT EXPERIMENTS it was recorded for this experiment that although increasing nitrogen rates had not affected survival, the numbers of supplies required significantly increased in the second season and onwards as the numbers of bushes per acre increased. This fact indicates that competition between bushes sets in at an early age and consequently every effort must be made to obtain a full stand at first planting.

Mean bush yields of pruning weights, recorded in Table XXVIII (a) and (b), substantiate the earliness with which inter-bush competition occurs. Leaf yields are not taken until after the first prune which is given at approximately 18 months after planting.

Table XXVIII

Fresh pruning weights per bush taken from the 'Complex' experiments

(a) *First prune at approximately 18 months after planting*

				Spacing			L.S.D.	
Replication				Planted	4' × 4'	4' × 3'	4' × (2' × 2')	P=0.05
First	..	..	..	Dec., '52	0.86	0.78	0.47	0.13
Second	..	..	..	Dec., '53	0.82	0.77	0.55	0.07
Third	..	..	..	Nov., '54	1.23	0.96	0.54	0.17

(b) *Second prune at approximately 30 months after planting*

				Spacing			L.S.D.	
Replication				Planted	4' × 4'	4' × 3'	4' × (2' × 2')	P=0.05
First	..	..	..	Dec., '52	1.08	0.92	0.55	0.09
Second	..	..	..	Dec., '53	1.09	0.86	0.57	0.09

(c) *Third prune at approximately 42 months after planting*

				Spacing			L.S.D.	
Replication				Planted	4' × 4'	4' × 3'	4' × (2' × 2')	P=0.05
First	..	..	..	Dec., '52	1.26	1.00	0.56	0.10

It is apparent from these data that inter-bush competition as measured by pruning yields, occurred during the first 18 months of growth. Pruning weights taken at first prune are the first weight recordings taken; the first yields of leaf follow this prune.

Nitrogen has not significantly affected pruning weights in any replication.

Made tea yields per acre are given in Tables XXIX (a) and (b) and XXX (a) and (b) below; the first table comparing spacing effects and the second nitrogen effects. There is no significant interaction between spacing and nitrogen rates.

Table XXIX

Yields in lb. m.t.p.a. according to spacing, from the 'Complex' experiments

(a) *Yields taken between 18 months and 30 months after planting, following first prune and before second prune*

					Spacing			L.S.D.
					4' × 4'	4' × 3'	4' × (2' × 2')	P=0.01
Replication					Planted			
First	Dec., '52	108	124	158	13			
Second	Dec., '53	369	439	583	40			

(b) *Yields taken between 30 and 42 months after planting, following second prune and before third prune*

					Spacing			L.S.D.	
Replication					Planted	4' × 4'	4' × 3'	4' × (2' × 2')	P=0.01
First	..	..	..	Dec., '52	541	655	806	43	

Each upward step in spacing has caused significant increases in yield for both first yields and second yields. The difference between seasons is well illustrated by the first table. Therein the yields for the first replication relate to the 1954/55 crop season and for the second replication to the 1955/56 season, which although it showed a total seasonal rainfall of nine inches less than the former was a much more efficient season for crop production.

The proportionate differences in crop for first yields between the two seasons is nearly constant for the three spacings; thus the 4' × 4' spacing in the second replication has yielded 3.4 times as much as its counterpart in the previous season: the factor for 4' × 3' spacing is 3.5 and for the hedge planting 3.6.

Table XXX

Yields in lb. m.t.p.a. according to nitrogen rates per acre, from the 'Complex' experiments

(a) *Yields taken between 18 months and 30 months after planting, following first prune and before second prune*

		Nitrogen rate p.a.			L.S.D.
Replication	Planted	20 lb. N	40 lb. N	60 lb. N	P=0.05
First	Dec., '52	123	132	134	10
Second	Dec., '53	443	472	475	30

(b) Yields taken between 30 and 42 months after planting, following second prune and before third prune

Replication	Planted	Nitrogen rate p.a.			L.S.D.
		30 lb. N	60 lb. N	90 lb. N	P=0.05
First	Dec., '52	642	676	684	32

The highest rate of nitrogen has just caused significant increases in crop over the lowest rate for the first yields. The medium rate just fails to cause a significant increase over the lowest rate and there are no significant differences between medium rate and the highest rate. From this table it appears that 40 lb. of nitrogen per acre (equalling 200 lb. of sulphate of ammonia) is little different in effect from 60 lb. of nitrogen. The return in pounds made tea for each pound of nitrogen added between 20 and 40 pounds of nitrogen per acre was 0.45 pounds for replication one and 1.45 pounds for replication two. It is very doubtful if these low returns would justify the expenditure on the extra fertilizer.

For the second yields, taken between 30 and 42 months after planting, 60 and 90 pounds of nitrogen per acre have caused a significant increase in yield over 30 pounds, there being no significant differences between the two highest rates. The return in pounds of made tea for each pound of nitrogen added between n30 and n60 is 1.13 and again it is very doubtful if this is economically worthwhile.

Permanent Shading of Mature Tea

(i) OBSERVATION PLOTS, SWAZI

Records continue to be taken from observation plots shaded with mature *Albizzia gummifera* and immediately adjacent unshaded tea, similar in age, jat and management methods to the former. Half of each plot receives no fertilizer and the remaining halves, sulphate of ammonia supplying the equivalent of 80 pounds of nitrogen per acre.

The tea in both sets of plots was heavily down-pruned in May 1955 (which was too late for quick recovery) and in September, 1955, counts were taken of the percentage of bushes in each treatment which showed active recovery. These are detailed in Table XXXI

Table XXXI

Percentage of bushes which showed active recovery from prune in September

	Without shade		With shade		Mean for Nitrogen
Without nitrogen	30	..	59	..	45
With nitrogen ..	26	..	48	..	37
Mean for shade ..	28	..	54	..	—

Tea under shade had made about twice the rate of recovery of its unshaded counterpart. Nitrogen had a slightly depressing effect.

Yields in pounds made tea per acre for the season are given in Table XXXII.

Table XXXII
Yields in lb. m.t.p.a. from shaded and no shade plots

	Without shade	With shade	Mean for Nitrogen
Without nitrogen	281	326	303
With nitrogen ..	391	370	380
Mean shade ..	336	348	—

This tea was also severely damaged by the same hail storm which affected the factorial fertilizer experiment.

For the first time in seven seasons of record, shade has caused only a slight increase in yield and nitrogen has been more effective than shade in increasing yields. The return for each lb. added to unshaded tea was 1.37 lbs. of made tea and under shade 0.55 lbs. The reduced efficiency under shade has been recorded in previous seasons.

(ii) SHADE TREES AND FERTILIZER EXPERIMENT, MIMOSA

In this formally laid out experiment the effects of four shade treatments are compared and are; no shade, *Albizzia gummifera*, *Gliricidia maculata* and *Grevillea robusta*. There is also provision for comparing the interplay of fertilizer treatments with shade treatments. Fertilizer treatments have not yet started.

The tea was planted in December 1951 and at the beginning of the 1955/56 season was therefore four and a half years old in the field. Shade trees were planted a year after the tea and have been supplied as necessary. In common with other experience in Mlanje, *Grevillea robusta* suffered severe damage from termite attack but with the introduction and application of 'Pestchlor', and 'Dieldrin' it was latterly possible to give a good degree of protection to *Grevillea* supplies.

Yields according to shade treatments are given in Table XXXIII.

Table XXXIII
Effect of shade trees on yields in lb. m.t.p.a.

Shade	<i>Gliricidia</i>	None	<i>Grevillea</i>	<i>Albizzia</i>	L.S.D.
Yield ..	545	610	662	665	P=0.01=35

Grevillea and *Albizzia* shade have caused significantly increased yields over no shade which in turn has significantly out-yielded the *Gliricidia* shaded tea. In last season's report the same order of yields was obtained but the differences were not significant and the comment made was, "of the three types of shade *Gliricidia* is the only one, as yet, which has made sufficient growth to produce anything approaching an effective shade and it is curious that it has been out-yielded by the others".

This season *Albizzia* in particular and *Grevillea* to a lesser extent have made sufficient growth and spread to offer a light shade over the majority of the tea bushes in their plots. *Gliricidia*, grown as an upright bush, made such heavy aerial growth that it had to be heavily thinned on two occasions. With the high degree of significance obtained this season there is little doubt that *Albizzia* and *Grevillea* must be regarded as having had beneficial effects and *Gliricidia* a detrimental effect. The reasons for shade affecting tea yields are by no means clear or simple. The *Gliricidia* bushes have developed a strong and widely spread rooting system in the surface layers of the soil and the reduction in yield caused by this shade might be due to competition between it and the tea for soil moisture, rather than by a detrimental effect of its shade *per se*.

Vegetative Propagation

In mid-April a start was made in investigating methods of vegetatively propagating tea as applicable to this country. The immediate requirement is one or more methods for use with the breeding programme and a longer term possibility is the development of a reliable and easy method of producing vegetatively, large numbers of plants for use in commercial scale planting or replanting programmes.

No concrete results are yet available for report.

Pests and Diseases

The season has been pleasantly free from pests and diseases and other sporadic outbreaks of mosquito bug (*Helopeltis bergrothi*); there was no alarm.

Termites, particularly on new planting, continue to cause damage but a satisfactory degree of control is possible with Dieldrin.

Meteorological Record 1955/56 at Swazi Tea Research Station, Mlanje

Month	Rain ins.	Rainy days	Running total	10 years mean	Mean monthly max. °F	10 year mean	Mean monthly min. °F	10 year mean	hours sun	2 year mean
July, 1955 ..	1.13	6	1.13	1.33	76.3	74.6	52.4	51.2	176	173
Aug. ..	1.33	1	2.46	2.75	79.8	78.0	49.4	51.4	225	226
Sept. ..	0.56	8	3.02	3.54	84.3	84.1	55.5	55.3	214	207
Oct. ..	0.84	6	3.86	6.17	90.0	90.0	62.7	61.4	254	291
Nov. ..	5.77	10	9.63	13.57	90.9	87.9	65.5	64.6	234	203
Dec. ..	18.82	15	22.45	24.97	86.2	86.2	66.1	65.7	213	174
Jan., 1956 ..	11.00	18	33.45	37.56	82.8	84.6	65.2	65.8	183	182
Feb. ..	7.44	23	40.89	49.99	85.5	84.4	66.5	65.7	199	173
March ..	10.45	23	51.34	63.36	84.7	82.3	66.2	64.7	164	152
April ..	18.58	21	69.92	70.15	79.3	81.5	63.5	61.7	132	187
May ..	3.38	12	73.30	72.92	78.9	77.4	57.2	56.0	181	195
June ..	3.34	9	76.64	75.27	74.9	73.7	54.7	52.1	150	149
TOTAL ..	76.64	152	76.64	75.27	—	—	—	—	2,325	2,312

COFFEE

1. Cultivation and Manurial Experiments. (Bvumbwe)

Results remain much the same as shown in the 1955 Report; the trees originally shaded with *Sesbania* and not mulched have not yet recovered from their initial setback although the treatment has been changed to include mulch of tung hulls.

TABLE I
Shade/Mulch Experiments

<i>Treatment</i>	<i>Mean Girth in cm. (Bvumbwe)</i>	<i>Mean Yield parchment in lb per acre (Naming'omba)</i>
M. No shade, mulched in rows	3.9	2,164
S.M. Shade of <i>Albizzia</i> (<i>Sesbania</i> at first); mulched ..	2.3	1,344
(1) Shade of tall bananas, mulch only from banana stems	2.3	1,123
S. Shade of <i>Albizzia</i> (originally <i>Sesbania</i>); no mulch ..	2.0	1,211
L.S.D. $P=0.05$	0.98	575
$=0.01$	1.48	871

NOTE.—1. As a rough guide 100 lb. parchment yields 85 lb. clean coffee. At 9 ft. $\times$ 9 ft. spacing there are 538 trees per acre.

2. Treatment at Bvumbwe now includes a mulch of tung hulls. Plots SM and S mulched at Bvumbwe with elephant grass to a depth of 6 ins. just before the rains and at Naming'omba with tung nut shells from the factory.

From the above table it can be seen that a temporary shade of *Sesbania*, if planted before the coffee is established (as at Bvumbwe) or after it is established (as at Naming'omba), is detrimental to the growth and yielding capacity of the coffee. Mulching is essential. Prunings from dieback showed that one-third less occurred on the mulched unshaded plots.

There were no significant responses at Bvumbwe to 200 lb./acre of sulphate of ammonia, 200 lb./acre of superphosphate or 100 lb./acre of muriate of potash.

Attacks by leaf miner were serious during the dry season and control measures may be necessary in addition to the normal control against *Antestia* and, where they occur, the two kinds of borer.

There is nothing yet to report of the other trial at Gala or the variety trials.

2. Fertilizer Trial (Nchenachena)

A trial in the Northern Province on *arabica* combines the effect of the application of sulphate of ammonia, superphosphate, dung, single and double stem pruning and Kents Hybrid against local seed. Yields were quite good but only the nitrogen and dung gave significant increases in yield. There was a significant interaction between sulphate of ammonia and variety, showing that Kents Hybrid was able to take greater advantage of the fertilizer than the local variety.

TABLE II
Significant Effects in Arabica Coffee Trial

<i>Treatment</i>	<i>Yield beans lb. per acre</i>
With sulphate of ammonia ..	433
Without sulphate of ammonia ..	310
With dung	461
Without dung	283
Interaction	
Sulphate of ammonia X Kents ..	62

FRUIT

Granadillas. The first season's yields of a training, pruning and manuring factorial experiment, planted in December, 1954, were obtained for the twelve-month period up to 31st July, 1956. It was hoped to determine the optimum time for pruning by observations made on side plots. But prunings made in April or May, after the summer crop, resulted in a small crop with a peak in December and a large crop with a peak in April and May, a pruning made in August resulted in a peak only in April and May the shape and size of the curve being much the same. The second pruning, made in May of this year, coincided with a *Fusarium* attack which killed almost all pruned plants but no others. The relation between pruning and fungus is not yet clear since death was ultimately caused by the formation of toxic substances in the region of the collar. The August pruning, if severe, is also likely to cause death or dieback from sunscorch since the vines are exposed to the hot sun of the next two months. Therefore it is not yet possible to make any certain recommendations as to pruning. Until the matter is investigated further, it should be sufficient to trim the droppers lightly when the crop is at its lowest, i.e., about August, and remove any dieback that may appear.

Other treatments are shown in the table below:

Yield fruit, lb/acre, (corrected for pruning effect).

<i>Experimental mean</i>	<i>Effect of Treatment</i>			<i>L.S.D. 5%</i>
	<i>T</i>	<i>N</i>	<i>P</i>	
12,480	+1060	+823	+292	+882

The telegraph or horizontal trellis (T), i.e. two parallel wires at 18 ins. apart is therefore significantly better than the horizontal or boundary system. Sulphate of ammonia (N) applied at the total rate of 2-3 lb. per plant in two dressings produced an increase in crop that just escaped significance. Superphosphate (P) produced no increase in crop and there is little to prove that it assisted in their establishment.

Soft Fruits. Both *Strawberries* and *Youngberries* are proving crops of commercial value. Of the strawberries the variety *Mwera Hill* was entirely lost to *Armillaria* attacks. Three new varieties, resistant to leaf spot, have been imported; yields per acre were as follows:

<i>Variety</i>	<i>lb./acre</i>						
					<i>1955</i>		<i>1956</i>
Nankunda (ex Zomba)	..	..	..	..	806	..	1142
Katete	..	..	..	..	3713	..	990
Vumba	..	..	..	..	1119	..	852
Salisbury	..	..	..	..	2531	..	1038
Cambridge Early Pine*	..	..	..	..	—	..	1921
Cambridge 449*	..	..	..	..	—	..	1888
Melba*	..	..	..	..	—	..	1973

* Leaf spot resistant.

The plants cropped from August to November inclusive. The 1956 crop was not irrigated as much as the 1955 crop. Of the first four varieties none is apparently consistently superior. The three new varieties appear to be better yielders.

It is hoped that there will be a system of measuring the irrigation requirements of fruits and other crops in operation within the next twelve months. Until then, loss of crop through under-irrigation as illustrated above is always liable to occur; similarly wastage of water and fungus diseases can easily attend over-irrigation.

The thornless variety of *youngberry* has proved capable of producing a high quality berry. It further has the advantage of being easier to handle. Tips must

not be allowed to root since, being a chimaera, the resulting plants will be thorned to a varying degree.

A small plot yielded the equivalent of 1025 lb./acre of good-sized fruit with less than the optimum amount of irrigation. This figure is based on a 10' × 10' spacing but closer spacing (6' × 10') could be adopted without detriment to the plants and would result in a proportionately higher yield.

Tree Tomatoes. The tree tomato (*Cyphomandra betacea*) is said in New Zealand to be a good indicator of the suitability of a location for the growing of citrus. Citrus has never succeeded at Bvumbwe; therefore it might be expected that tree tomatoes would fail. Three varieties were planted to test the theory—a red local and two New Zealand selections, red and yellow; mean yields per plant were 8.4 lb., 8.7 lb., and 8.5 lb., respectively and there are already signs of dieback. Under suitable conditions in New Zealand they should bear over 30 lb., per plant at maturity and should last over ten years after planting. A virus disease, causing severe leaf mosaic, attacked some plants and was proved to be transmissible by the bud-patch technique.

This crop might do well under irrigation at a locality such as Tuchila or Chitedze.

Tomatoes. In addition to granadilla juice there is a possible market for tomato juice or puree. An experiment to discover the potentialities of the crop at Bvumbwe gave a mean yield for all plots of just over 11 short tons per acre. The crop was grown at the end of the rains on the residual moisture in the soil plus 3.91 ins. of actual rainfall. Water loss was reduced by mulching but there was no irrigation. The variety *San Marzano* was grown. The treatments applied showed no significant differences probably because all plots grew well after the initial application of 10 tons acre of dung and 2 ozs., per plant of fertilizer C (4 : 18 : 12) at time of planting. Plots that received a heavy manurial treatment of 2 ozs., per plant of fertilizer C every fortnight after flowering showed only a slight response, probably because it was not washed in the soil; there was in fact about 12 per cent. loss of fruit due to blossom end rot, which is a sign of water shortage or irregularity.

The factor most nearly significant was the earlier planting (by a fortnight), i.e. 18th April (sown 29th February) which gave a higher yield. No pruning, although there were only 120 plants per plot, gave as good as or a slightly greater yield than pruning where there were 180 plants per plot; the size of the fruit was, however, smaller. Training to a stake or wire would seem to be desirable; costs of production were recorded.

There were no attacks by blight, some foliage was damaged by *Septoria lysopersici*.
Mwera Hill

An introduction of Feijoa, the pineapple guava, was made and this has begun to yield. The flavour is of good quality and it is expected to yield well.

AGRICULTURAL CHEMISTRY

Report of Agricultural Chemist, Bvumbwe

Oil and Oil Seeds

GROUNDNUTS

150 representative samples of exported nuts were examined for oil content, the range being 43.8–51.5 per cent., only five samples containing less than 45 per cent. oil.

Tung Oil

(See under Tung Report)

Soils and Nutrient Studies

(a) LEACHING ACTION OF AMMONIUM SULPHATE

In view of the increasing use of ammonium sulphate, it was interesting to be able to complete the findings of a small ammonium sulphate leaching experiment, done through the last rains. Light and heavy soils were placed in 9 in. pots, and sulphate of ammonia was applied to the soil in amounts equivalent to 300 lb. (N_1) and 600 lb. (N_2) per acre. The experiment was also repeated with the incorporation of cattle manure in the soils, at a rate equivalent to 2 tons per acre.

The pots were left outside throughout the rainy season (1954-5). Analysis of the soils taken from the 1 in., 6 in., and 9 in. horizons were then made. The mean of duplicate figures are shown below. It was planned to analyse the leachates collected, for ammoniacal and nitrate nitrogen, so that the nitrification changes could be followed, but pressure of work prevented this part of the investigations.

TABLE I

Leaching effect of Ammonium Sulphate													
<i>Heavier Soil</i>							Base Cap. 10.4 Cly. & St. 30 per cent.) Initial pH 6.23						
<i>D</i>	N_1			N_2			N_1+CM			N_2+CM			
	<i>pH</i>	<i>N</i>		<i>pH</i>	<i>N</i>		<i>pH</i>	<i>N</i>		<i>pH</i>	<i>N</i>		
1"	5.90	.19	..	5.58	.24	..	5.83	.21	..	5.80	.15		
6"	5.74	.14	..	5.44	.14	..	5.60	.15	..	5.42	.05		
9"	5.54	.08	..	5.29	.12	..	5.51	.13	..	5.27	.05		
<i>Lighter Soil</i>													
Base Cap. 5.6 Cly. & St. 10 per cent.) Initial pH 6.32													
<i>D</i>	N_1			N_2			N_1+CM			N_2+CM			
	<i>pH</i>	<i>N</i>		<i>pH</i>	<i>N</i>		<i>pH</i>	<i>N</i>		<i>pH</i>	<i>N</i>		
1"	6.10	.06	..	5.62	.09	..	5.99	.08	..	5.64	.08		
6"	5.94	.03	..	5.60	.07	..	5.68	.06	..	5.72	.06		
9"	5.92	.04	..	5.61	.06	..	5.76	.09	..	5.60	.05		

The initial nitrogen content was .15 for the heavier soil and .09 for the lighter soil. From these figures, it is seen that the higher dressings of sulphate of ammonia have caused a greater reduction in the pH of the soils, and that the addition of cattle manure has lessened the effect. Based on the nitrogen content of the soils, the lighter soil has retained far less ammonium sulphate, and this emphasises the need to make split dressings of fertilizers on lighter soils.

(b) NUTRIENT STATUS OF S. PROVINCE SOILS

A nutrient status map was prepared, summarizing the data obtained on estate and other soils of the Cholo-Mlanje-Zomba area, the classification being as follows:—

TABLE II

	<i>Low</i>	<i>Medium</i>	<i>High</i>
Organic Carbon per cent. ..	<1	1-2	>2
Nitrogen per cent. ..	<0.1	0.1-0.2	>0.2
Potassium m.e. per 100 gm. ..	<0.4	0.4-0.8	>0.9
Phosphate p.p.m. (NH_4F extract)	<15	15-40	>40

This classification is shown on the attached map. But it should be stressed, as indicated in last year's Report, that these figures are only general, and the many localized variations make it necessary to deal with soils problems on a "field" unit basis at least.

(c) TEA

(i) Forty-six soils were examined from an old estate in the N. Province which was to be converted to tea production. Most of the area consisted of sandy soils throughout the profile, which would be too light for tea. In the areas of sandy loams overlying clay loams, the proportion of clay and silt was lower than found in the Southern Tea Areas. The pH of the soils was satisfactory (5.1–5.7) but their nutrient status was generally low in respect of nitrogen, phosphate and potash, although occasionally the “medium” level was reached.

(See also Report of Ecologist—Chombe Estates.)

(ii) Various minor problems were investigated from nurseries and main plantations. Localized areas of higher pH were generally the source of trouble.

(d) The importance of satisfactory nutrient supply was investigated in connection with an area of *Coffee* in Cholo affected by *Fusarium* and free from *Fusarium*—it was thought that a nutritional deficiency might lead to a lowering in resistance of the plant and consequent attack by the fungus. Analysis, however, showed little chemical difference in the soils. There was a significant physical difference in the field—affected coffee growing on a compacted soil with poor drainage, not allowing root penetration.

A further coffee problem investigated was the dieback at Chamaoya, where leaf analysis showed the affected coffee to contain only 1.2 per cent. N against 3.2 per cent. in satisfactory coffee from Bvumbwe. The application of ammonium sulphate immediately rectified the trouble.

(e) LAKE CHILWA AREA

To complete the work extensively reported last year, sampling of Lake Chilwa water was continued, and the following are the results.

TABLE III

	August	October	January	March	April
pH	8.6	8.6	8.9	8.7	8.1
Total salts, pp 100,000	55	100	92	94	68
Sodium	29	27	55	17	13
Chloride	25	40	34	6	5
Carbonate	7	3	10	3	nil
Bicarbonate	37	70	163	72	136

The potassium, calcium and magnesium contents were fairly constant at 1–3, 1.5–2.5 and 0.5–1.5 respectively, as found previously.

Generally, these figures are rather lower than found in 1954–55, the former being the result of a succession of dry “rainy” seasons. It is interesting to note the effect of the later rains, where evaporation continued longer, the maximum concentration continuing until January, as against October in the previous year. The effect of the heavy late rains is seen in the dilution of the Lake indicated by the April Sampling.

Effect of Saline Water on Soil

The experiments described in last year’s Report were continued throughout the dry season in order to try and obtain an accelerated effect of continued irrigation with saline water.

The plots were sampled at the end of the dry season (December) to depths of 0–2 ins., 2–6 ins., and 6–12 ins., but the results were inconclusive, and the sodium content showed no increase on the figures reported last year.

(f) TOBACCO

(1) In view of the Tobacco Research Board's publication on Fertilizer recommendations, there has been an appreciable increase in the number of soil samples submitted for classification according to the Board's system. In view of the data in section 2 (a) it would be interesting to resolve how far the high levels required on the lighter soils are due to anticipated leaching losses.

(2) Leaf samples from one estate, where potassium deficiency was apparent, were found to have the following composition.

TABLE IV

					Healthy Leaf %		Deficient Leaf %
Nitrogen	..	..	..	..	1.2	..	2.2
Phosphate	..	..	..	..	1.1	..	0.8
Potassium	..	..	..	..	8.3	..	2.5
Sodium	..	..	..	..	0.1	..	0.1
Magnesium	..	..	..	..	2.5	..	1.5
Calcium	..	..	..	..	1.2	..	2.9

(g) SOIL SURVEY

One hundred and forty-nine samples were examined for the Ecologist (*q.v.* Report of the Ecologist). From Sawale, the soils were medium to strongly acid sandy loams, overlying soils of slightly higher clay content. Their nutrient status was generally low for nitrogen and phosphate—although the potassium status occasionally reached the medium level.

Further samples from the Fort Johnston area were generally slightly to medium acid loamy sands to sands. At Chipoka, soils of similar texture had a neutral to slightly alkaline reaction.

Generally, the organic matter status was low except at Nankumba, where it reached 7.0 per cent. the nitrogen content followed closely the organic matter, and being similarly low, except at Nankumba where it was 0.25–0.3 per cent. The available phosphate supplies were medium to high, except at Chiyendausiku and Manjawira, where they were negligible. The potassium content of the soils was medium to high, and in the Nankumba soils of high organic matter content, the figure was m.g.e. per gm.

(h) ELEPHANT MARSH RECLAMATION

In connection with a possible experimental site for a reclamation trials, 105 samples were examined from the Karonga Lagoon area. The soils could be divided, very roughly, into three textural classes, viz. clays, sandy clay loams and sandy loams. As might be expected, the heavier soils are found in the lagoon proper—there being a decrease in clay content the further a soil is from its centre.

As a general rule, the soils are well supplied with phosphate and potash—organic matter and nitrogen contents tend to be low, although part of the area (the western half of the lagoon) can be considered fairly well supplied. Base Exchange capacities are generally high, particularly in the case of the heavier soils.

The apparent picture of reasonable fertility is offset by the often high alkalinities and salinities. The only area of slightly acid to neutral soil is at the western half of lagoon where, as has already been remarked, the organic matter and nitrogen status is satisfactory. These soils are, however, heavy clays and would doubtless present practical difficulties if worked.

There are several localized areas of extreme alkalinity and/or salinity. Two pits are very saline up to 0.8 per cent. at depth and two are in the saline/alkali group (1.0 per cent. salts and pH 10.2) whilst three other pits are extremely alkaline. These small "patches" are obviously valueless agriculturally but further pits must be sunk before their boundaries can be precisely delineated. The sandy clay loams, though usually of reasonably low salinity, are, on the whole, rather too alkaline for the average crop. The sandy loams, again usually of reasonably low salinity, are less alkaline than the sandy clay loams and therefore of more potential value. Several of the pits classified generally as clays show sand at comparatively shallow depth—a point to be watched when irrigation is contemplated.

The soils differ considerably from those of the area of the Elephant Marsh, reported last year, which are predominantly clays, although clay-over-sand or pure sand are occasionally found. In reaction, they are usually neutral to slightly alkaline, with only a very few acid profiles. Some soils become moderately alkaline at depth, with calcareous deposits. The two sets of soils are similar inasmuch that organic matter and nitrogen contents are low but phosphate and potash supplies are satisfactory. The outstanding difference appears to be salinity. The total soluble salts range for the Elephant Marsh soils is 0.01—0.24 per cent.—the 0.24 per cent. being an exception, the usual value being around the 0.01–0.10 per cent. mark. Yet the Karonga Lagoon soils range from 0.02–1.02 per cent. and high salinities are as common as low. There again, high alkalinities (as much as pH 10.3) are found. The general impression is, therefore, that the Karonga Lagoon samples are not as potentially valuable as those of the Elephant Marsh. This may be due to the landlocked nature of the lagoon, which is only occasionally inundated from the surrounding area. The more alkaline and saline nature of the soils on the banks of the lagoon, compared with those under water, is more pronounced than found elsewhere on the edge of the marsh. Further information should be available from the detailed survey shortly to be made.

Pastures and Feeding Stuffs

(1) HYDROCYANIC ACID IN STAR GRASSES

Following reports of death of cattle by hydrocyanic acid poisoning from pastures in South Africa, the HCN content of *Cynodon Plectostachyum* was determined at various times of the day and under varying weather conditions.

The following contents have been found:

TABLE V

Date	Time				HCN p.p.m.	p.c.	Lb. of grass to kill average animal (approx)	
19/12/55	..	Mid-day	..	..	nil	..	nil	..
20/12/55	..	Mid-day	..	..	99	..	0.01	..
31/12/55	..	Early Morn.	..	..	462	..	0.05	..
3/ 1/56	..	do wilted	..	..	440	..	0.04	..
13/ 1/56	..	Late. Aft.	..	..	208	..	0.02	..
19/1/56	..	Early Morn.	..	..	35	..	0.004	..
20/1/56	..	Mid Morn.	..	..	nil	..	nil	..
1/2/56	..	Early Morn.	..	..	nil	..	nil	..

It appears that the hydrocyanic acid content of grasses is a very elusive factor. The probable explanation for the figures quoted is that the end of December saw the grass lush and succulent after a flush. As it became more mature so the hydrocyanic acid content diminished.

(2) FEEDING STUFFS, ETC.

During the year a number of silage samples and other materials have been examined, the results being as follows:—

TABLE VI

<i>Silage Composed of</i>	<i>Rhodes and Elephant grass, velvet beans</i>	<i>Rhodes grass, Napier fodder Desmodium Intortum</i>	<i>Maize with salt</i>	<i>Maize with molasses</i>	<i>Rice poor quality</i>	<i>Bran good quality</i>
Moisture, p.c.	81.2	80.1	79.7	71.3	8.1	9.6
<i>Analysis on dry matter basis</i>						
Crude protein	7.6	13.0	3.6	5.0	5.6-6.6	12.6
Ash	13.2	8.7	9.3	12.1	16-6	2.4
Ether extract	2.9	3.4	2.2	1.9	—	—
Crude fibre	22.9	14.6	14.0	11.2	—	—
Carbohydrates	53.4	60.3	70.9	69.8	—	—

MISCELLANEOUS

(1) 1,427 river samples were examined for silt content in connection with the Hydrological Survey.

(2) Samples of compost from Soche Township were found to be of low nutrient content (0.3 per cent. N, 0.2 per cent. P and 0.8 per cent. K) and advice was given on the use of suitable materials for improving the quality, as inert absorbents were being used.

(3) Samples of waste liquor, from a local tea factory was found to contain insufficient caffeine and tannin to be of commercial value.

Report of the Agricultural Chemist, Chitedze

SOILS AND NUTRIENT STUDIES

1. FERTILIZER EXPERIMENTS

Routine analyses were carried out on over 90 soils received from research stations and African gardens in the Central and Northern Provinces, with a view to correlating the analytical data with fertilizer responses.

(a) *Maize*. In continuation of the work of finding a closer correlation between soil analyses and phosphate response, and responses to other major nutrients, a somewhat more complicated experiment employing three rates of N and P was put down, in place of the simpler one previously used, on eight Agricultural Instructors' Gardens in the Lilongwe District, and on two sites at Chitedze. These soils were specially selected, after analysis of a large number, as being representative of a wide range of textural groups with variable nutrient status. The season's results indicated that this new type of experiment was fully justified as much more satisfactory correlations were obtained than before and in consequence this work is to be continued on a much bigger scale, soils from the Northern Province being included, during the coming season.

(b) *Tobacco*. Similar experiments to the one described above were laid down on four of the tobacco estates in the Lilongwe District and on two sites at Chitedze. Three of these were devoted to Burley and three to Western, the sites being chosen in the same way on these for the maize experiments. Correlations from these experiments, however, were somewhat inconclusive due to several mishaps and poor yields. As with maize, the work is to be continued on a considerably larger scale next season.

2. ADVISORY WORK

Throughout the year over 70 samples were analysed for various tobacco estates and fertilizer recommendations given. As previously, the main need was for a build-up of organic matter status in order to improve the availability of soil nutrients generally. It is hoped that the accuracy of recommendations will be greatly increased as an outcome of the fertilizer experiments to be carried out on several estates in the coming season.

3. MISCELLANEOUS SOIL WORK

(a) With a view to observing changes in organic matter, nitrogen supplies and nutrient status over long periods a selected number of treatments on the major rotation experiments at Chitedze are to be sampled annually. This season saw the commencement of the work and 182 samples were analysed in this connection at the beginning of the rains.

(b) Fifteen profiles were examined for the Ecologist, from Kilapula, North Karonga, with a view to the suitability of the area for irrigation. Texturally, the soils showed much variation and were highly stratified, many of them becoming markedly alkaline at depth, and the general impression was one of unsuitability.

OILS AND OIL SEEDS

Groundnuts. Sixty-two samples of groundnuts were received from markets throughout the Central Province during the season, and were examined for moisture and oil content. The oil content (dry kernel) was found to vary considerably, ten of the samples having less than 45 per cent., 33 with between 45-47 per cent., and 19 in the range 47-49 per cent. Mean percentages for moisture content, testa and oil content were as follows;

TABLE VII

Analysis of Groundnut samples

Average moisture content as received	..	..	..	5.2%
Average testa percentage	..	..	..	3.6%
Average oil content (moist sample plus testa)	..	..	..	42.3%
Average oil content (dry kernel less testa)	..	..	..	46.3%
Average difference between oil content of whole moist seed and that of dry kernel	..	..	..	4.0%

Prior to the buying season most markets in the Central Province submitted groundnut samples for moisture determinations, and some 70 tests were carried out revealing that due to the late rains nearly all samples contained a higher percentage of moisture than normally expected at time of buying.

LEAF ANALYSIS

1. FLUE-CURED TOBACCO

(a) Samples of good leaf and leaf badly infected with *Alternaria* from several estates in the Kasungu District, were examined for differences in the N, P, K content. While no conclusions could be drawn from the amounts of P and K, the N content was shown to be somewhat higher in the badly infected leaf.

Mean per cent. N in good leaf	..	1.78 per cent.
Mean per cent. N in badly infected leaf	..	2.22 per cent.

(b) Leaf samples from an N.P.K. trial at Lisasadzi Experiment Station were also analysed to observe the effects of the various treatments on uptake of N, P and K by the leaf. The results are tabulated below.

TABLE VIII
Leaf analysis Flue-cured tobacco

<i>Pounds per acre</i>			%N	%P ₂ O ₅	%K ₂ O
N	P	K			
12	0	0	1.69	1.33	5.40
12	0	90	1.55	1.14	6.36
12	100	0	1.80	1.92	4.92
12	100	90	1.71	1.46	5.30
24	0	0	2.04	1.60	4.39
24	0	90	1.39	1.29	6.36
24	100	0	1.74	1.82	4.15
24	100	90	1.58	1.50	6.41

2. OTHER TOBACCO—see under Tobacco Report.

3. MISCELLANEOUS SAMPLES

A sample of Russian Comfrey grown at Chitedze was analysed and found to compare very favourably with that grown in South Africa and Southern Rhodesia. The analysis was as follows:—

TABLE IX
Analysis of Russian Comfrey

	<i>Per cent.</i>				
Moisture	..	..	..	..	86.0
Nitrogen Free extract	..	..	..	..	44.0
Crude Protein	..	..	..	..	22.1
Ash	..	..	..	..	17.6
Fibre	..	..	..	..	10.9
Potash	..	..	..	..	7.2
Ether Extract	..	..	..	..	5.3
Phosphate	..	..	..	..	0.5

SILT ANALYSIS

Two hundred and fifty-six water samples from the Northern and Central Provinces were analysed for silt content and conductivity (p.p.m.), for the Water Development Department.

SOIL PHYSICS STUDIES

A. SOIL MOISTURE STUDIES AT CHITEDZE

Preliminary investigations were commenced on the moisture use of three major cultivated crops (maize, groundnuts and tobacco), compared with that of indigenous volunteer weeds, and the effects of two types of fallow (clean weeded and shallow rooted cover crop) in storing moisture in the soil profile to a depth of 10 feet, this more than adequately covering the root ranges of all the crops and fallow treatments, as previously determined during the 1954/55 season.

Soil Type and Experimental Layout

A level site was selected composed of a chocolate coarse sandy clay loam, soil depth varying from 8-10 ft. The experimental layout consisted of six 1/13th acre plots (approx.) one for each of the treatments used as per diagram.



Growing Season (Crop Report)

The experiment received a total of 37.17 inches of rain during the season, evenly distributed, though some late rain was encountered at the end of April and the middle of May.

Maize. This got away to a poor start due to an infestation of army worm and the majority of the plot had to be replanted, a somewhat uneven growth resulting. As the season progressed however, the growth evened out and a good crop was harvested at 180 days, with a calculated yield of approximately 20 bags per acre.

Tobacco. Western tobacco was used, some 325 seedlings being wet planted at the end of November. Nearly all the plants took initially and a clean even stand resulted, producing a calculated yield of 1,400 lb. leaf/acre.

Groundnuts. Again a very even stand was produced resulting in a calculated yield of 1,100 lb. seed/acre.

Teff. (*Eragrostis abyssinica*—a shallow rooted and short season grass). The newly germinated seed was destroyed by the army worm infestation and had to be replanted at a rate of 40 lb./acre when a dense stand was produced giving excellent cover. The first heavy crop of seed was harvested 74 days after replanting, towards the end of February, and after the seed heads had been removed regeneration commenced and a second seed crop was harvested 43 days later.

Volunteer Cover

The plot was completely cleared prior to the beginning of the rains and the natural vegetation allowed to colonise it during the wet season. An exceptionally heavy stand giving excellent cover, and reaching a height of approximately 8 ft., was produced.

Bare Fallow

This plot was also cleared prior to the rains and kept clean-weeded throughout the whole season.

Cultivation and hand weeding was carried out on all plots, with the exception of the volunteer cover, throughout the season.

Installation of Gypsum Blocks.

Cylindrical gypsum blocks, for use as soil moisture indicators, were manufactured (from a design by Pereira) prior to the onset of the wet season. Once the rains commenced these were installed at various depths down to 10 ft. under the different plot treatments, being placed gradually as the movement of the moisture front down the profile allowed. Two replicate profiles of blocks were installed in the maize, groundnut and tobacco plots, and one set only on the teff, volunteer cover and bare fallow plots. It is hoped to install a second set of blocks under the three latter treatments during the coming season.

On each treatment the gypsum moisture units were placed at random at 6 ins. and at foot intervals down to a depth of 10 ft., using hand augers and various placement tools. Regular readings were taken throughout the season and are still being continued, and these have shown very clearly the approximate moisture status at any time at a given depth under any of the treatments.

Soil Moisture Sampling.

The real value of the moisture blocks lies in the fact they have been able to indicate when moisture sampling of the various treatments was required. All treatments were sampled to varying depths at different stages during the season, the soil being removed by hand augers, and moisture contents on an oven dry basis were determined in the laboratory. Rough bulk density determinations were also carried out at foot intervals down the profile in order to convert the moisture sampling data into equivalent inches of rain present under the various profile treatments at different times during the season.

Results.

At the time of writing this Report there is only sufficient information available to allow no more than a brief indication of the effects of the various treatments on moisture utilisation and storage.

TABLE X
Moisture Storage and Utilization Data under Six Crop Treatments at the end of the Wet Season

<i>June 1956</i>	<i>Groundnuts</i>	<i>Tobacco</i>	<i>Maize</i>	<i>Bare fallow</i>	<i>Teff</i>	<i>Volunteer cover</i>
Ins. water in first 6 ft. of profile	19.20	18.24	17.64	16.69	16.66	13.89
Calculated ins. water in first 6 ft. of profile held at field capacity	22.02	22.02	22.02	22.02	22.02	22.02
Calculated ins. water in first 6 ft. of profile held at wilting point	13.68	13.68	13.68	13.68	13.68	13.68
Calculated ins. available water between F.C. and W.P. in first 6 ft. of profile	8.34	8.34	8.34	8.34	8.34	8.34
Ins. available water remaining under different treatments in first 6 ft. of profile ..	5.52	4.56	3.96	3.01	2.98	0.21

Discussion. A depth of 6 ft. has been taken in Table X as this is the range over which the most significant changes occurred and in which the bulk of roots was found. The main points arising from the data given above are as follows:—

(1) A considerable amount of available moisture is shown to be present under the three cultivated crops when compared with the teff and bare fallow treatments, which one would not expect after a heavy cropping. This can probably be attributed to two things,

(a) Late rain after harvesting, which partially filled up the profile again. Unfortunately, owing to other commitments it was not possible to obtain figures for available moisture under the various crops at time of harvest.

(b) The three crop treatments were ridged and these would accept and retain the moisture from the late rains to a greater extent than under bare fallow or teff which were not ridged.

2. Although the tobacco was harvested during March, the groundnuts in April and the maize in May, the amount of available moisture remaining under these three crops gives an indication of the extent of their various root systems and their effect on drying out the profiles.

3. The amount of available moisture present under teff approximately equals that under bare fallow and clearly demonstrates the value of growing a shallow rooted cover crop to maintain soil structure and prevent compaction and run off, which are responsible for a lessening of rainfall acceptance on the bare land.

4. The effect of the volunteer cover of indigenous weeds has been to reduce the first 6 ft. of the profile to almost wilting point. This means that considerably more water has been removed by the natural vegetation than that used to produce any of the three major cultivated crops. In areas where drought conditions are likely to prevail this could have a very adverse effect on the survival of a subsequent crop.

5. Some further loss of moisture conserved under the various treatments can be expected from two sources:

(a) Continued extraction of moisture by root systems remaining, particularly those of the volunteer cover and to a certain extent teff.

(b) An increase in drainage brought about by all the profiles becoming appreciably warmer during the dry season.

It is hoped to present a rather more detailed report at the end of the coming season.

B. MOISTURE STUDIES AT OTHER STATIONS

This is a brief report on preliminary investigations, connected with various aspects of soil moisture work as it affects different crops, which have been commenced at the following three stations.

Tung Station (Bvumbwe)

Moisture blocks have been installed under apricot, peach and plum trees at various depths to 4 ft. to act as indicators for frequency and amount of irrigation required by fruit during the dry season. The effects of not irrigating on soil moisture are also being studied simultaneously, similar sets of blocks having been placed under non-irrigated trees.

Sets of blocks have also been placed under tung trees to be irrigated and non-irrigated, during the dry season to ascertain if there is any direct effect on biennial-bearing.

Tea Station (Swazi)

Soil moisture differences under pruned and unpruned tea are being examined and an experiment, consisting of three replicate sets of blocks under pruned and three under unpruned bushes, placed at varying depths to 10 feet, has been commenced. Moisture sampling, in conjunction with block readings, has already shown as expected, a considerable conservation of water under the pruned tea bushes.

Cotton Station (Makanga)

Eight replicate sets of blocks have been placed to a depth of 6 ft., to act as indicators with a view to studying the application of varying amounts of irrigation water to cotton at different time intervals during the season.

LUNZU-LIRANGWE-LINJIDZI SURVEY



REPORT OF THE ECOLOGIST

Lunzu-Lirangwe-Linjidzi

A preliminary Land classification survey was carried out in the area bounded by the Shire River, the Linjidzi River, Walkers' Ferry road, the Chileka-Blantyre road and the foot of the escarpment running parallel to and north of the Zomba-Blantyre main road.

The initial survey was strictly in the nature of a reconnaissance and no quantitative data were assembled.

The land can be roughly divided up into nine areas. The first six lie parallel to the Shire River.

I. SHIRE FRINGE

A dry stony, much broken region, with limestone ridges.

VEGETATION:—Low scrubby woodland characterized by *Terminalia sericea*, *Pterocarpus chrysotrix*, *Sterculia quinqueloba*, *Diospyros kirkii*, *Bauhinia petersiana* and *Commiphora fischeri*. Occasionally the community swings towards *Brachystegia boehmii*, particularly near Walkers' Ferry. Typical of the herbaceous layer is the grass *Schmidtia bulbosa*.

SOILS are shallow and stony, of very little value. There are pockets which are cultivable but unsuited to maize. Sorghum, grown in the same garden as maize was in much better condition. Along the Shire there are pockets of better soil, colluvial and alluvial in nature. These are of very limited extent and of little value in a broad scheme of planning.

II. MICHIRU-CIPALANJE HILL COUNTRY

A hilly region with two prominent hill masses, Michiru and Cipalanje. The area is mostly uncultivated but there are a few fertile valleys already occupied.

Vegetation:—(a) *Brachystegia boehmii*, *Pseudoberlinia globiflora* woodlands with *Pseudolachnostylis maprouneifolia*, *Brachystegia manga*, *Bauhinia petersiana* and *Diplorrhynchus mossambicensis*.

(b) On the large hills *Brachystegia tamarindoides* is common.

(c) And on lower rocky kopjes *Brachystegia bussei* with *Elephantorrhiza goetzii*.

(d) The narrow valleys with colluvial soils have vegetation typified by *Terminalia sericea*, *Piliostigma thonningii*, *Lonchocarpus capassa*, *Combretum* spp. and the tall *Hyparrhenia* spp.

SOILS. Except in the valleys the soils are shallow, stony and poor but are carrying fair timber. In the valleys good soils have been formed by colluviation and stream deposit and are carrying good maize crops. They are limited in extent.

UTILIZATION. The narrow valleys are carrying population probably to their limit but little use is made of the woodlands. Apart from a few *Pterocarpus angolensis* there are few timber trees.

CONSERVATION. The narrow valleys by virtue of their limited extent are in need of protection. Some works are already in hand but somewhat inadequate. The Africans already plant bananas which do quite well and are a valuable alternate carbohydrate food source.

III. RIDGE AND VALLEY COUNTRY

Broken country with numerous fertile valleys. The hills are fertile where the depth of soil allows cultivation. Villages are scattered throughout the area.

VEGETATION. *Brachystegia boehmii*, *Brachystegia manga*, *Diplorrhynchus mossambicensis*, *Pseudoberlinia globiflora*. woodlands with sparse herbaceous covers.

SOILS. Fertile in the valleys, often fair on the slopes and ridges, but with much shallow and stony soil in parts.

UTILIZATION. The valleys are carrying population but there may well be land that could be utilized on the slopes and ridges if conserved and managed well. To find these lands would require a very close grid survey, as the distribution of good soil is patchy. Maize in many places was poor but cassava and groundnuts do fairly well. Cattle and sheep are found in the broken country on extensive grazing in the woodlands or on the seasonal swamps. Much erosion results from the latter practice, whilst scrub has resulted from overgrazing the woodlands. Erosion due to cattle is also very prevalent where cattle are grazing slopes near villages.

IV. THE CENTRAL BELT

A rolling plain, very fertile with almost continuous cultivation of maize.

VEGETATION. Tall open woodland dominated by *Pterocarpus angolensis* and *Terminalia sericea*.

SOILS. Deep, fertile dark red soils, sandy clay loams.

UTILIZATION. This belt is densely settled and cultivated and almost entirely down to continuous maize. There is no doubt about it being fertile and under an organized system of farming should become more productive. The number of people cultivating the area is difficult to estimate without detailed survey but the gardens were well weeded and cultivated, indicating adequate labour. Cattle appear to be lacking in this central belt but are encountered on its margins.

V. THE TOBACCO BELT

A more broken section, the boundaries of which are difficult to define where they are in contact with IV. Densely cultivated, with many European estates. This region is designated the tobacco belt because the estates in the area are primarily tobacco concerns.

VEGETATION:—(a) *Brachystegia boehmii* mixed woodlands.

(b) *Acacia campylacantha* woodlands with *Piliostigma thonningii*, *Pterocarpus angolensis* and *Afrormosia angolensis*.

SOILS. The difference between the rich reds of section IV and the lighter reds of V is difficult to define without fuller details. The vegetation, however, readily indicates the difference and in the classification no difficulty arises. The soils are better suited to groundnuts and flue-cured tobacco than to maize production.

The soils of the colluvial areas are very fertile and generally carry *Acacia campylacantha* in numbers.

UTILIZATION. Populations are generally dense and particularly so when Blantyre is approached. Cattle are common in the area and grazing apparently sparse with resultant scrub and overgrazing.

VI. THE ESCARPMENT AND ESCARPMENT FOOT COLLUVIUM

The escarpment country, very broken and steep with cultivation along the colluvium at the foot.

SOILS Shallow on the escarpment but rich at the foot.

UTILIZATION. The escarpment foot is densely populated. The hill slopes are not so populated but there are cultivations and often on considerable slopes.

VII. THE LUNDU HILLS

A hilly section with much barren slope but with densely cultivated valleys.

VEGETATION. *Brachystegia boehmii*, *B. manga*, *B. bussei* woodlands.

SOILS. Light buff and shallow, except in the valleys where colluviation has given rise to some fertile soils. Even the latter are often very stony in places and require immediate soil conservation to preserve them.

UTILIZATION. Maize production is fair in this area. The valleys are quite densely populated.

VIII. THE LINJIDZI VALLEY

Mopane country, with heavy soils.

VEGETATION. Mainly *Colophospermum mopane*, with vegetation typical of alluvia along the river valley proper.

SOILS. Black, calcareous clays to poor dark-brown cemented mopanosols, with rich fertile alluvia along the valleys. The country is not broken but low rolling.

UTILIZATION. Population is generally low, probably due to the lack of knowledge of how to work the mopanosols. Tradition elsewhere has it that mopanosols are difficult and intractable. On the edges of the mopane country, however, maize is growing extremely well. Black soils of a similar type are used elsewhere for cotton production, *i.e.*, Ngabu. This area would require a close grid soil survey to determine the distribution of the black soil through the mopane woodlands. The alluvia are densely occupied and in places badly cultivated.

IX. OPEN GRASSLAND NEAR THE SHIRE

An open grassland near Cigaru which is used as grazing.

GENERAL CONSIDERATIONS

1. THE UPPER CATCHMENTS—(a) The land above the escarpment is densely occupied by African cultivators and European estates. In part (the Lirangwe dambo), it has been subject to concentrated conservation measures, but not as part of the present *Lirangwe-Lunzu* catchment scheme.

(b) The *Lunzu* headwaters are dominated by large plantations of Eucalyptus.

(c) The *Linjodzi* catchment is only represented in the survey by the lower reaches of the S.w. bank.

2. CATTLE. The distribution of cattle and grazing grounds is erratic. Further survey of a more detailed nature is required to ascertain accurately the distribution and ownership of the cattle and the nature and extent of the grazings. The ownership of the cattle is by few individuals with large herds thus a great deal of damage to natural resources is done by few people.

Brachystegia woodlands are used as extensive grazings but they have poor grass covers and in many places grazing has given rise to dense scrub woodland. Cutting and thinning of scrub gives the grass more chance to become vigorous but if stumping is not practised then the trees regenerate and there is reversion to scrub in a few years.

3. CROPS. In the Lirangwe-Lunzu belt the economic crop is maize, sold to the high density area of Limbe and Blantyre. The present picture in the district is one of almost continuous maize cultivation with very few pure stand groundnut crops.

Groundnuts grow well in sections III to VII and are a crop to be encouraged in rotations because of their beneficial effects on subsequent crops.

Cassava is found in all regions and is a good drought crop. It is of especial value in region III where it is better able to resist adverse conditions than maize.

Sorghum is widespread and is suited to the areas marginal for maize.

Bananas find a small place in the local economy.

Tobacco is grown on European estates and fire-cured tobacco used to be grown in the Lirangwe area.

4. SIZE OF HOLDINGS. The average present size of holding and its returns cannot be estimated without a close sample survey. It appears, however, that the smaller holdings are nearest to Blantyre. It is also obvious from the crowds which use the Chileka-Blantyre, Lunzu-Blantyre roads that many of the holdings represent part-time farming activities.

5. CONSERVATION. A great deal of good work has been done in the area but there are some very poor patches with severe erosion. This is especially so in hill foot regions where there are no storm drains. Cattle are also the cause of much sheet erosion and scrub-land.

The Lower Reaches of the Palombe and Sombani Rivers

An ecological, land use survey was carried out in the area between the lower reaches of the Palombe and Sombani Rivers.

SOILS AND VEGETATION

1. RIVER ALLUVIA. The soil type of the cultivated area between the two rivers is alluvium, most probably spilt by the Palombe River and old drainage lines running South-east from the present river towards the Sombani.

The profile varies from place to place but is generally a heavy alluvium of a few inches to several feet upon stratified sands of varying degrees of coarseness; finally upon a heavy, grey-brown mottled, clay. The clay shows cracks, smooth polished surfaces and some sand wash into the cracks. The profile indicates a complicated history of soil deposition under lake, swamp and river conditions.

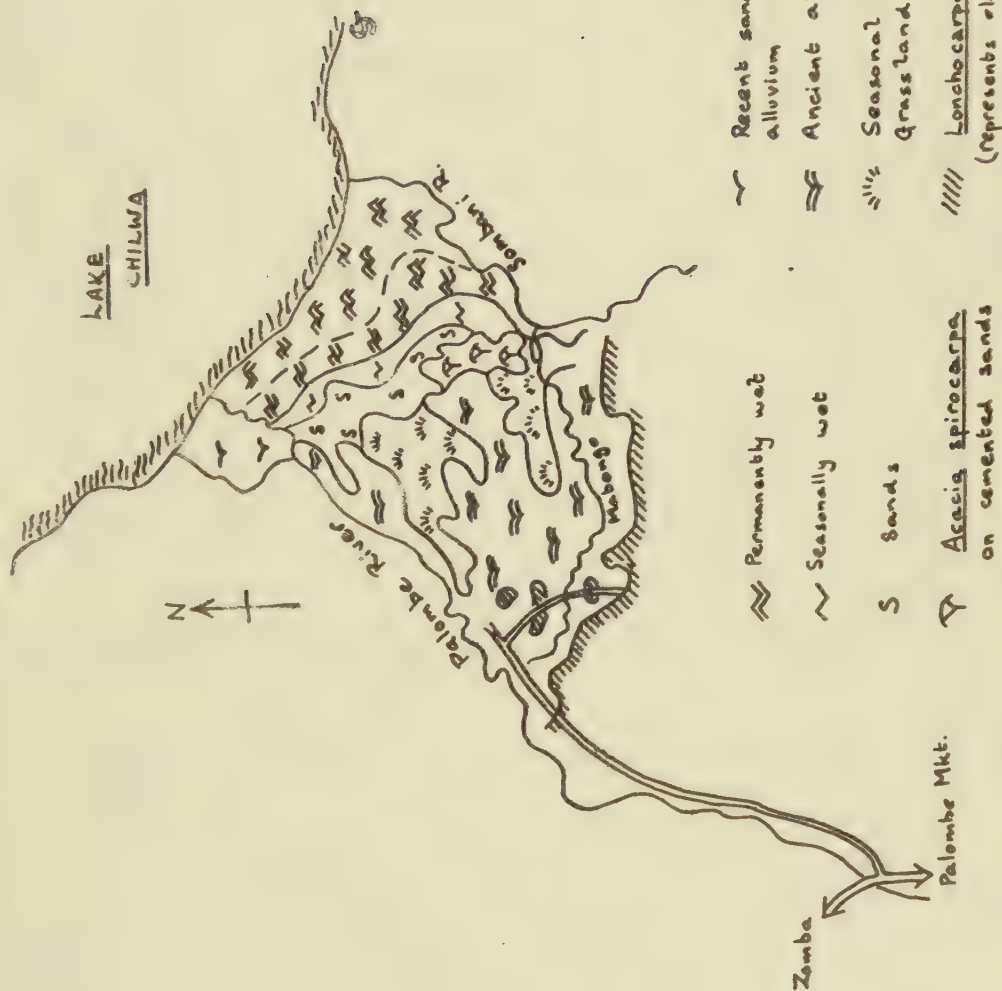
The vegetation is largely of relic nature, the area being heavily settled and cultivated. There remain numerous *Kigelia* sp. and *Ficus* sp., often in graveyard areas, with *Sterculia africana*, *Adansonia digitata*, *Ostrya derris stuhlmannii*, *Hyphaene ventricosa* and *Sclerocarya caffra*, indicating that the area resembled part of Fort Johnston and Chikwawa Districts.

Faidherbia albida is found near the Palombe River and along the Mabongo on more recent alluvial deposits.

2. SEASONAL SWAMPS SOILS. Along the drainage lines and basins are found heavy clays, grey to very dark grey or brown in colour, frequently with deep cracks, angular crumbs at the soil surface and showing gilgai or hog-wallow phenomena.

(a) At the headwaters of the swamp system the swamps have a scrub cover, dominated by *Lonchocarpus capassa* with *Acacia nilotica* var. *kraussiana*, *Piliostigma thonningii*, *Acacia seyal* var. and *Albizia harveyii*.

THE LOWER REACHES OF THE PALOMBE AND SOMBANI RIVERS.



(b) The swamp margins often carry a stand of *Hyphaene ventricosa* which may be associated with salinity to some extent as there are also "pan" areas as under (c).

(c) At the headwaters of certain tributary swamps, south of Njobvu, are limited pan areas with clumps of *Cappariaceae* with dense stands of *Blepharis* sp. in the open glades. The soil surface is whitish with a sand wash. Some rice gardens are cultivated close to and probably into the pans.

(d) The open swamp proper carries grassland with *Chloris gayana*, *Setaria* sp., *Dicanthium papillosum*, *Cynodon plectostachyum* and *Hypparrhenia rufa*. There are variations in the soils, which could only be picked up by grid survey and similarly in the vegetation which could not be classified at the time of the survey. However, the following observations were made:

(i) Gilghai or hogwallows are not universal on the swamp.

(ii) Very gravelly phases occur near the channel of the Mabongo at the margin of the swamp and scattered tree grassland. Probably representing old lake-shore lines.

(iii) There are in the grassland distinct belts of *Chloris gayana* which show up remarkable clearly after the fires.

(iv) There are also in the swamp, belts of land carrying scrub and small trees. These show up clearly on the air photos but are too narrow to depict on the map.

(v) Anthills have a distinct distribution on the swamp and often carry *Cappariaceae*.

(e) *Wooded Grasslands*. These are mostly to the south of the Mabongo and Sombani Rivers and carry *Albizzia harveyi*, *Acacia seyal* var., and *Piliostigma thonningii*. The soils are heavy clays overlain by a heathy litter filled with grass rhizomes.

(f) *Swamp soils* in pockets in the alluvial areas. The alluvial area is very uneven in surface and presents a rolling aspect. In drainage lines and hollows heavy clay pockets are found in which the inhabitants grow rice.

3. **THE SANDY SOILS.** At the western edge of the grasslands, and between them and the Lake, is an area of sandy soils which may be an old beach of Lake Chilwa. Further North the old banks and beaches become very clearly defined but in the South they are degraded and indistinct.

The areas of *Acacia spirocarpa* dominated woodland may not be true sand soils and require further investigation. At the time of survey they were extremely hard and cemented.

There is a distinct rise on to the sandy areas between the grasslands and the lake.

Towards the Palombe River the sand ridges carry sapling *Adansonia digitata*.

4. **THE LAKE MARGIN.** The soils were not investigated, because the area lay outside the proposed scheme. However, the grass covers of the lake margins with *Vossia cuspidata*, *Panicum repens* *Paspalidium gemminatum* are of importance to the economics of the area, as they provide grazing for cattle.

5. **SILTY SANDY ALLUVIA.** At the mouth of the Palombe there is an area of recent silty sandy alluvia which is used for rice cultivation.

CULTIVATIONS AND OCCUPATIONS

POPULATION. The dry lands of the area are densely populated by Anyanja who cultivate maize on the alluvia and some "Kidney" rice in the swamp tributaries and

along the margin of the Mabongo swamp; who fish for profit from the Tanga and Ngangala docks and a few individuals of whom keep numerous cattle.

MAIZE. The whole of the alluvia are densely settled and cultivated for maize. The soils appear very fertile, although marginal to the swamps, crops are subject to waterlogged conditions in the heavy rains.

Ridges are made by the people but of the short ridge type which resembles elongated *matutu*. There is considerable waste of garden space because of the numerous gaps in the ridges.

RICE is cultivated on the swamp margins and in swamps in the alluvia. It is poorly cultivated, widely spaced and of the red rice variety. The gardens show no attempt at bunding or water control.

The following excuses are given for poor rice cultivation:—

- (1) Birds eat the grain,
- (2) Kidney rice does not like too much water,
- (3) Faya rice wants too much,
- (4) The cattle trample the gardens.

There are numerous "Kidney" rice gardens at the mouth of the Palombe.

TOBACCO is found along the Mabongo near to the Cigumukira stores. It is being grown on alluvium with nurseries along the river banks.

CATTLE. There are numerous cattle in the area. They are the property of a few individuals who thus have at their disposal a disproportionate area of land. They are generally responsible for the deterioration of natural grazing.

(a) There are wide cattle tracks down to Lake Chilwa where cattle are taken to water and to graze on the semi-swamp grassland during the dry season.

(b) The soils of the natural Rhodes Grass grasslands are puddled by numerous hooves in the wet season and the grass is damaged and the cover reduced.

(c) The scrub at the heads of the swamp is the result of overgrazing and the cattle now browse on the shrubbery. It is interesting to note the following two points. (i) The cattle observed on the shrubberies were not in such good condition as those grazing at the Lake margin. (ii) The cattle were browsing and relishing *Piliostigma thonningii* bush.

(d) The cattle enter and damage rice gardens in the growing season.

FISHING. Practically the whole of the population are occupied in fishing for profit. There are two docks in the area at Tanga and Ngangala and at the latter there is a thriving fish trade. The money that is being turned over is reflected in the price of bamboos which sell at the Lake for 1s-6d each, making it well worth the while of local traders to employ motor transport.

The result is that the people's main interests are fishing and subsistence cropping.

Also resultant from the fishing community is the decimation of the timber resources. Huge canoes are being hauled into the area from many miles away and small canoes are made from the few remaining *Ficus* or other species.

WATER SUPPLIES. The Palombe River was quite dry at Cigumukira, two days after rain, although there was a lagoon near the old Agricultural Department plots. The Mabongo was quite dry but the soils in the vicinity were damp and to some extent plastic.

It is of interest to note that the Mabongo Stream arises close to the Palombe River and spills into the Sombani system. Locals say deriving water from the Palombe itself. The Mabongo is a depression, which flows through a densely populated section of the area. There is also a second possible drainage line south of the Mabongo also flowing into the Sombani system, which does not show a clear river line but is as an open scrub covered *dambo* arising near the Palombe west of the Mabongo. These scrub covered *dambo*s probably indicate the line of old Lake margins. It is interesting to compare the recent situation at the North end of the Lake, described in last year's Report, with this ancient situation in the South.

Ecological and Soil Survey of Chombe Estates, Nkata Bay District

An ecological and soil survey was carried out on Chombe South Estate in the Nkata Bay District.

1. METHOD OF SURVEY

Chombe South was chosen as the site of the first survey, owing to its accessibility and partial development. It was intended to use aerial photograph techniques to aid the investigation but they were not immediately available and so were only used in the final interpretations.

Transects were cut from the northern boundary to the southern boundary of Chombe South in such a way that they cut across the general lie of the land. The actual siting was rather difficult, owing to the nature of the topography, but for preliminary survey the lines proved satisfactory. 2 ft. pits were dug at every 220 yards and every fourth pit along the transects was deepened to 6 ft. so that the profile could be examined. Five transects were cut on Chombe South.

Only two transects across Chombe North were examined, owing to the very heavy going and lack of time, but the interpolation with the aid of air photographs and the stereoscope, based on the more detailed survey of Chombe South, is considered to give a reasonably accurate picture.

2. EXAMINATION

The technique for classifying the pits was based largely upon the profile morphology. Colour was assessed, using the Munsell Standard colour charts, and texture by moistening samples and by handling; as most of the profiles exhibited no clear horizons these two factors were most important.

At each site vegetation types, topography, profile moisture, presence of stones, roots and charcoal, were recorded.

3. SOILS

The soils fell readily into six field categories.

(1) *Brown sand upon orange loamy sand*

A deep loamy coarse sand soil with no marked horizons. The colour changes from dark brown (5 YR 3/4, dark reddish-brown) to orange (2.5 YR 5/8 red) in the subsoil. The texture is very sandy throughout with very little structure, no rock fragments or rotting rock perceived at a depth of 120 ins. $\frac{1}{4}$ in. roots were observed at 60 ins. depth. The profile was damp.

(2) *Red loamy sands*

These appear to be a phase of the above and the only morphological difference being a redder tone to the subsoil sand and a change to the 2.5 YR hue occurring nearer to the soil surface.

(3) *Red loamy sands and sandy loams*

Intermediate, between the brown-orange loamy sands and the red sandy clay loams, there is a soil phase with a more loamy texture than the true loamy sands. the colour hue is also more red (2.5 YR). Mica is apparent in the soils nearest the boundary of the red sandy clay loam.

(4) *Red sandy clay loams*

The nature of this soil is such that on wetting to assess the texture the immediate reaction is to label it clay. However, there is a considerable sand content readily detectable. The undisturbed profile demonstrates no clear horizon characteristics there being a gradual colour change from brown surface soil (5 YR 4/4 reddish-brown) to red subsoil (2.5 YR 4/8 red). If truncated by erosion the surface has a redder hue. According to site there appears a layer of rotting rock at about 36 in. to 60 in. The rotting rock is readily broken in the fingers and can in some cases be rubbed down with very little pressure having the nature of a mudstone. Associated with it are quartz fragments and grits. To the south-west corner of the estate the soils are denuded so that the quartz is close to and on the surface, probably following old cultivation sites. The texture in the undisturbed profile is crumbly with good root penetration.

(5) *Yellow brown gritty or sandy clay loams with mottled horizons*

Occurring near the edges of perennial stream and semiscasonal swamps is a soil type associated with seasonal high water table. The colour is more yellow-brown than in foregoing types (5 YR 5/8 yellow red) and has a distinct mottled horizon with yellow brown, yellow red and red mottlings. It is probably derived by colluviation from the red sandy clay loam and the sandy phases from the orange loamy sand. It contains much grit.

(6) *Grey dambo and other swamp soils*

These soils were not classified but included grey sands and sandy clays, black sandy clays and other soils associated with perennial or seasonal swamps carrying edaphic grassland or riparian palm forest.

4. TOPOGRAPHY

The brown-orange soils are generally on flat land, on the "plateaux" watersheds of the two estates.

On Chombe South they lie on a fairly unbroken piece of topography whilst on Chombe North there is a distinct erosion tongue into the "plateau".

The intermediate soil types, as one might expect, are on gently sloping to flat land on the margin of the brown orange loamy sands area.

The red sandy clay loams are characterized by a very broken and rolling topography with drainage streams in the valleys. Often the valley bottoms have a narrow belt of grey sandy soil with much mica apparent. To the S.W. corner of Chombe South the topography is very broken and the soils truncated and immature.

The yellow browns are situated at the bottom of slopes to river and stream systems and extend into the valley bottoms.

The dambo soils occupy the valley bottoms and generally carry edaphic grassland. They are flat with impeded drainage.

5. CLIMATE

Climatic data were not available for Chombe but figures are available for Nkata Bay, Vizara, Limpasa Dambo, Chinteché and Mzuzu. The stations quoted are all, with the exception of Mzuzu, nearer to the Lake-shore than Chombe. Mzuzu is the station nearest to Lunyangwa on the Vipya Mountains. Vizara and the Limpasa Dambo are the nearest stations. Vizara probably enjoys a slightly wetter climate than Chombe due to its close proximity to the Vizara hill range.

All the stations quoted fall well within the classic minimum average rainfall for tea (60 ins. per annum) when the yearly average is considered; although Mzuzu falls below this for 1953.

The distribution of the rainfall follows a monsoon pattern and the bulk of the rain falls from November to April. The soils on Chombe were damp in September and rain fell quite heavily on several days during August.

1951-1954					
<i>Summer</i>			<i>Winter</i>		
<i>Nov. 1st to April 30th</i>			<i>May 1st to Oct. 30th</i>		
			<i>Total</i>		
Chinteché	..	60.92	..	9.18	70.10
Vizara	..	78.86	..	16.48	95.34
Nkata Bay	..	58.81	..	11.90	70.71
Mzuzu	..	45.40	..	9.45	54.85

From a statistical analysis of the annual rainfall it can be predicted that in nine years out of ten the lower and upper limits of annual rainfall at these four stations will be :—

				<i>Lowest</i>	<i>Highest</i>
Mzuzu	..	..	..	31	73 inches
Vizara	..	..	..	57	128 "
Nkata Bay	..	..	..	52	117 "
Chinteché	..	..	..	41	95 "
				<i>1953 Total</i>	<i>Average Yearly Total</i>
Chinteché	..	..	..	77.84 ins.	70.16 ins.
Limpasa	..	..	..	74.62 "	89.06 "
Vizara	..	..	..	81.82 "	93.05 "
Nkata Bay	..	..	..	64.58 "	63.80 "
Mzuzu	..	..	..	42.85 "	61.32 "

6. DRAINAGE

The soils of the brown-orange loamy sand and the red sandy clay loams appear to be well drained. No evidence of mottling was seen in any dug profile except in valley sites to the S.W. of the estate. One pit (3/9/955) showed a faint mottle and was situated near a drainage line.

The yellow brown soil of the lower slope and valley bottoms showed a clear mottling and increased clay with depth, suggesting water-logging.

The *dambo* soils are seasonally or perennially water-logged.

7. WATER SUPPLIES

Between Chombe North and South (I & II) there is a large perennial stream draining into the Limpasa system. This is the Lilezi rising in the hills to the west of Chombe North.

Chombe South has a perennial stream, the Kaulasisi in the S.W. Corner and the Nkwale which is rather ill-defined but perennial at the southern border. The Lilezi is actually within the northern boundary in places.

8. VEGETATION

(1) The brown orange loamy sand carried a tall stand of *Brachystegia spiciformis* with other species. The undergrowth varies from a dense tangle of evergreen shrubs and lianes to a thick stand of evergreen shrubs with *Afromomum* species, *Smilax craussiana* and *Dracaena* sp. There is little or no grass cover apart from sparse *Megastachya mucronata*.

(2) *Erythrophloeum* sp. is a frequent constituent of the *Brachystegia* woodland but the intermediate types and on the red sandy clay it assumes greater conspicence.

(3) *Brachystegia longifolia* with *Uapaca* sp. is typical of the yellow-brown mottled soils in the seasonal semi-swamp sites. Associated perhaps with a slightly drier phase *Cryptosepalum* sp. is also found.

(4) The Edaphic grasslands of the swamp sites vary in composition and were not studied in detail. *Monocymbium cerissiforme* and various representatives of the *Arundinelleae* were noted.

(5) Riparian forests with numerous palms, including *Raphia vinifera* and *Elaeis guineensis*.

9. WEEDS

Numerous weeds already exist in the rubber plantations:—

(1) *Cuscuta* sp.—Dodder. This is extremely prevalent in places forming dense tangles over shrubbery.

(2) *Cryptosepalum* sp. A creeping, woody perennial similar to a miniature *Brachystegia* is found in dense patches in the plantations but usually where the soils are of the yellow brown group.

(3) *Pteridium* sp. Bracken. There are several areas where Bracken is common. In Ceylon this plant is taken as an indicator of tea soils.

(4) *Imperata cylindrica*—Alang Alang or spear grass. Prevalent in wetter places.

10. GEOLOGY

At several places on steep sloping topography, outcrops of rotten rock resembling mudstone were noticed. Subsequent examination of the area by the Geological Survey Department revealed that the soils are derived from Cretaceous lacustrine deposits.

11. CHARCOAL

In the profiles of the brown-orange loamy sand and the red sandy clay loam numerous charcoal pieces are to be found to depths of 6 ft. It is thought that these are roots which have been carbonized *in situ*.

12. *Armillaria mellea* was noticed in the *Brachystegia* woodland.

13. CHOMBE N.

The interpretation of the data for Chombe North has been mainly from aerial photographs and three line transects.

The interpretation was based upon the following criteria:—

(1) The line transects and chisel pits revealed that the soil types on Chombe North are essentially the same as on Chombe South.

(2) The brown-orange loamy sand occupies the main centre of the estate and is on flat "plateau" topography.

(3) The red sandy clay loam occurs on broken topography and was mainly observed along the northern boundary.

14. RUBBER

In most cases where rubber is grown on Chombe South the soil belongs to the red sandy clay loam type and it seems that a soil survey must have been carried out before the plantation took place so rarely does the crop occur off this soil type.

15. SUITABILITY OF THE ESTATES FOR TEA

Classically, tea requires rainfall and temperature to maintain continuous growth throughout the year; an easy naturally draining soil; a penetrable subsoil and with an acid reaction around pH 5. At Chombe the soils appear to be suitable morphologically, the brown-orange loamy sand being permeable and easy draining and the red sandy clay loams not showing marked signs of water-logging except in valley sites, and there only faintly. The red sandy clay loam also exhibits a good crumb structure which is not broken down unless the sample is moistened and kneaded.

The Vegetation in the Vicinity of Chikwawa

When the Yellow Fever Survey Team visited Nyasaland the Ecologist accompanied them to determine the habitats of *Galago crassicaudatus* and *G. senegalensis*.

The following vegetation communities were encountered in the survey:—

(1) ALLUVIUM

(a) *Faidherbia albida* on alluvial fans. Tall woodland, open, heavily cultivated; e.g., Lipanga and Nkate.

(b) *Sterculia appendiculata*, with *Cordyla africana*, *Kigelia pinnata* and locally *Hyphaene ventricosa* and *Kirkia acuminata*. Sometimes with *Combretum* spp. thickets.

Tall parkland, heavily cultivated; e.g., Shire Valley at present level.

(2) TERRACE ALLUVIUM AND COLLUVIUM

(a) *Sclerocarya birrea* with more or less:—

Sterculia africana, *S. appendiculata*, *Cordyla africana*, *Tamarindus indicus*, *Lonchocarpus capassa*, *Strychnos* sp., *Boscia salicifolia*.

Woodland, sometimes with thickets. Generally cultivated.

(b) *Acacia spirocarpa* predominant with *Acacia campylacantha*, *A. nigrescens*, *A. subulata*, *Albizia harveyi*. Tall woodland with thickets and glade. *A. spirocarpa* regenerates densely in old cultivations.

Best developed near Chikwawa and Katunga but encountered elsewhere.

(c) *Acacia nigrescens* with more or less of the species given in 2 (b). Tall woodland where *A. spirocarpa* predominates. Extra species include *Holorrhena febrifuga*, *Combretum ghasalense*, *Dalbergia melanoxylon*. Found on the Sunbu Road: near Mtumba River, Chapangananga Road.

(d) *Acacia xanthophloea* with *A. campylacantha*, and *Cordyla africana*. Restricted to the vicinity of rivers and seasonally wet areas. Woodland, sometimes with thicket and dense annual leguminous creeper cover. e.g., Banks of the Mwanza; near Katunga at Kasandula.

(e) *Pterocarpus stevensonii* standards with *A. nigrescens*, *Cordyla africana*, *Tamarindus indicus* and dense complex thickets with trailing and climbing *Acacia* sp., *Grewia* spp., *Cissus* spp., *Capparis* sp. and *Courbonia* sp., e.g., Mitole thickets at Chikwawa; thickets near Mbenje.

(3) PIEDMONT COLLUVIAL

(a) *Terminalia sericea*, *Ostryaoderris stuhlmanii*, *Piliostigma thonningii*. Tall forest with a well developed understory and thickets where not cultivated. Generally densely occupied. e.g., Foot of the eastern escarpment.

(b) *Sclerocarya birrea* found in the valleys of sandstone ridge country.

(c) *Acacia nigrescens* with *Dalbergia melanoxylon* and *Albizia harveyi*.

(4) HILL

(a) *Brachystegia boehmii* with *Pterocarpus angolensis* and *Sterculia quinquiloba*. Open woodland on steep stony slopes of the Eastern escarpment.

(b) *Diplorrhynchus mossambicensis*—*Combretum* sp. with *Diospyros kirkii*, *Pseudolachnostylis maprouneifolia*, *Terminalia sericea* and *Sterculia quinquiloba*. Short open woodland with medium grass cover on Basement complex ridges on the Chapanagera Road.

(c) *Pterocarpus rotundifolius* predominates in certain over 4 (b) species. A slightly denser and taller woodland than 4 (b).

(5) SANDSTONE AND SHALE SERIES

(a) *Colophospermum mopane*, tall open woodland in almost pure stand with short grass cover. Found near the Lengwe and along the Sumbu Road.

(b) *Kirkia acuminata* with *Adansonia digitata* and *Fagara* sp. Tall woodland with very dense thicket. Found on coal-bearing shales along the Sumbu Road.

(c) *Grewia* spp., *Commiphora* spp., *Dalbergia melanoxylon*, *Euphorbia* spp. thickets on ridges along the Sumbu road.

(d) *Brachystegia* sp. with *Commiphora* sp., *Cassia* sp. and *Pseudolachnostylis maprouneifolia*. Tall woodland thicket and understory. Sandstone country on the Sumbu Road.

(e) *Pseudoberlinia globiflora* with *Pterocarpus angolensis* and *Terminalia sericea*. Tall open woodland with little understory and short grass. Road to Sumbu coalfield area.

The *Galago* spp. were found most frequently in those woodlands with *Acacia* spp. This may have been connected with their feeding habits in the early dry season as several, when examined, had gummy substances in their stomachs. The most likely source of gum would be from the *Acacia* spp.

Sawale Village

A soil survey was carried out at Sawale Village new-settlement area in the Balaka district. The area is situated about $2\frac{1}{2}$ miles south of Toleza farm in the triangle formed by the Balaka-Kalembo Road, the main Zomba-Fort Johnston Road and the main North Road.

TOPOGRAPHY

A low rolling area, at an elevation of approximately 2,100 ft. above sea level and slightly higher than the nearly Rivi-Rivi and Liwawadzi plains.

The area is drained to the south by the Cimwalira, to the east by the Miruli—Nkonde system and by the Liwawadzi to the west. All three systems are cutting back into the area and there is active erosion.

SOILS.

(1) RED BROWN COARSE SANDY LOAM ON COARSE SANDY CLAY LOAM. The main and most valuable soil type of the area designated in the field red-brown gritty clay loam. At the time of the survey the soil was very hard and difficult to dig. On sampling and wetting, the soil breaks down rapidly and the clay fraction is very apparent to the touch. Coarse grit is also readily detected. The ease with which a clod disintegrates in water is of importance when considering soil conservation measures.

The type pit yielded the following data:—

A dark yellowish brown (10 YR 4/4 dry 10 YR 2/2 moist) sandy loam, pH 5.1, on a reddish-brown coarse sandy clay loam, pH 4.9 (5 YR 4/4 dry 5 YR 3/6 moist) structure blocky, breaking up into angular nutty particles. Cracks are deep down the profile but neither wide nor frequent. The surface of the dug profile shows numerous cut grits and the samples, kneaded with water, display large mica flakes. At about 48 ins. there is a faintly perceptible mottle with a few black spots. At about 75 ins. rotten rock with pegmatite is reached. Rocks giving rise to the soil type include garnet and hornblende gneiss and pegmatite. The nitrogen status is marginal, phosphate and potash medium.

(1a) TRUNCATED RED BROWN COARSE SANDY CLAY LOAM. There is evidence that the area has at one time been occupied as old grinding stones and potsherds were found. A possible consequence of this old occupation was the truncation of the red brown soils to give very shallow soils on gravel or even stone and gravel at the surface. These conditions are found in the N.E. block of the area set aside for Sawale. Such places are useless for cultivation.

(2) DARK YELLOW BROWN COARSE SANDY LOAM. These soils are found on the slopes towards the drainage lines. The surface soil is a dark grey-brown coarse loamy sand on a dark yellow-brown coarse sandy loam with a distinct mottling at depth when close to the drainage line. Marginal to the red brown soils the colour of the soil is more brown to strong brown. The soil is acid and the nutrient status rather poor.

(3) DARK GREY BROWN TO DARK BROWN OR BLACK COARSE SANDY CLAY LOAMS.

These soils are found in the drainage lines, are very dark in colour with calcareous material at depth. Chemical analysis reveals a high percentage of sand but the soils crack, harden in the dry season and are difficult to work. They are of relatively small extent. The soils are acid in the surface and alkaline below 18 ins. depth.

(4) There is a fourth soil type that is less easily defined. The profile shows a slightly brighter colour than the red brown soil but the texture is similar. In many cases the resemblance is to the truncated phase. The vegetation is however markedly different being *Pseudoberlinia globiflora* with *Brachystegia boehmii*.

VEGETATION

The vegetation for most of the area is a *Combretum*—*Lonchocarpus*—*Sclerocarya* complex. Where the soils are in good condition it is a tall, fairly open woodland with little understory. Worn out phases are characterized by the dominance of low *Combretum ghasalense* and are probably better suited to the planting of forest produce. Bamboos should grow well as they are found naturally in the area. The poor areas with stones near or on the surface carry *Pseudolachnostylis maprouneifolia*, *Monotes* sp. and *Diplorrhynchus* sp.

Elsewhere on the red brown soils *Afrormosia angolensis*, *Bauhinia petersiana*, *Acacia campylacantha*, *Ostrya derris stuhlmanii*, *Pterocarpus rotundifolius* and *Lannea* sp. are found.

Afzelia quanzensis, a valuable timber tree, grows wild in the area along the numerous narrow rocky ridges and could be increased in numbers as a long term policy.

Brachystegia boehmii—*Pseudoberlinia globiflora* woodland with *Diplorrhynchus* is found on the Eastern boundary.

The gullies and badlands near the headwaters of the streams have a thicket vegetation with numerous *Grewia* spp., *Commiphora* spp., *Dalbergia melanoxylon*, *Pteleopsis myrtifolia*, *Schrebera* sp.

Acacia campylacantha is frequent along the stream valleys and on the black and dark brown soils, together with *Piliostigma thonnighii*, *Lonchocarpus capassa* and *Ficus* sp.

Kirkia acuminata is also found in the area.

EROSION

The main problem in the area is erosion. The red-brown soils are highly erodible. A sample, when immersed in water, disintegrates rapidly and actively and forms a sludge. The topography at the head-waters of the river systems is of a badlands type with steep sided valleys and sharp ridges. The slopes are often strewn with gravel and stones. Elsewhere there are sharp edges or small cliffs of soil from a few inches to over 16 ft. deep. These edges are numerous and of great length in many places and surround the area of good land.

CROPS.

On nearby village holdings maize, groundnuts and tobacco all do well. Soya beans might well be tried as an alternative legume crop. Pigeon Pea is found in the area and does well and could be used for the resting lands.

Chloris gayana does well at nearby Toleza and is found in natural stands in the vicinity.

The problem of "Dambo" grazing in Central Province

The problem of overgrazing on the seasonal and river swamp areas of the Lilongwe District has been of recurrent interest in the past season. Because of pressure on the land, cattle in many areas are being forced to graze on the "dambo" grasslands for nine months of the year with subsequent erosion and sward deterioration.

Generally speaking the seasonal swamps are dominated in the summer phase by *Hypparrhenia* spp. including *H. nyassae*, *H. gazensis*, *H. bracteata*, *H. filpendula* var. *pilosa* and *H. newtonii*. Other species include *Setaria sphacelata*, *Echinochloa pyramidalis*, *Leersia hexandra*, *Eulalia geniculata*, *Hemarthria altissima*, *Panicum* spp. and *Eragrostis* spp. With overgrazing the sward is rapidly converted to a pure stand of *Sporobolus pyramidalis* with an intermediate phase of *Urochloa pullulans*. Current with the advent of the *Sporobolus* there is usually a gully formed down the centre of the drainage line.

In places in the district there are ungrazed grasslands and there is some obvious maldistribution of grazing, but on the whole the trouble is widespread. The only long term solution lies in the provision of adequate wet season pasturage in the upland areas so as to reserve the swamp grazings for the dry season. This state of affairs is hindered by the fact that garden distribution is haphazard and unplanned, that the value of resting leys for cattle is not yet realized by indigenous cultivators and the fact that ownership of cattle is very unevenly distributed amongst the population.

HERBARIUM

About 500 specimens have been added to the Herbarium. Salisbury Herbarium have kindly named several collections in the past year.

REPORT OF THE PLANT PATHOLOGIST

The Plant Pathologist assumed duty in the Protectorate on the 10th September, 1955. Much of the first year was spent in becoming familiar with the country and crops, a total of 82 nights being spent away from Zomba on tour. During the same period 27 one-day visits were made locally.

NEW RECORDS

During the many necessarily brief visits made, opportunity was taken to collect specimens for the herbarium. The following are the more important new records for the Protectorate:

Mycosphaerella musicola Leach in the conidial stage only on bananas in the Nkata Bay area.

Glomerella cingulata (Stonem.) Spauld and Schrenk. causing a serious dieback and leaf spotting of granadillas in the Cholo area.

Fusarium stilboides Wr. (Storey's A1 form of *Fusarium lateritium* Nees ex Fr. var *longum* Wollenw.) from *Coffea arabica* suffering from a form of dieback, again in the Cholo area, and also from coffee suffering from a collar rot at Nchenachena.

Fusarium oxysporum (sensu Snyder and Hansen) isolated from the collar region of granadilla plants suffering from a collar rot.

Armillaria mellea (Fr.) Quel. has extended its recorded host range in the Protectorate to teak (*Tectona grandis*), strawberry (*Fragaria vesca*) and granadilla (*Passiflora edulis*).

INCIDENCE OF DISEASE IN ECONOMIC CROPS

MAIZE

Puccinia polysora Underw. This disease was again widespread, but appeared to do little damage except in localized areas. A survey carried out in October, 1955, and a similar survey in November, 1956, failed to reveal any sign of the rust in the Lower River areas. The reason for its disappearance at this time (the driest part of the year) is possibly climatic, as it was reported widespread in these areas in July of both years.

Helminthosporium turcicum Pass. was widespread, and Maize streak virus was also widespread, particularly in *dimba* gardens in the Lower River, where the incidence of infection appeared high, and damage was greatest.

As a result of very wet conditions while the cobs were ripening, and after harvest, cob rots were widespread, and did some damage in the Southern Province. Among

these were *Nigrospora oryzae* (Berk and Br.) Petch, *Fusarium moniliforme* sensu Snyder and Hansen and *Fusarium graminearum* Schw. Some infection by species of *Aspergillus*, *Penicillium* and *Rhizopus* also occurred

GROUNDNUTS

Both *Cercospora personata* and *Cercospora arachidicola* were widespread throughout the groundnut areas, and it is hoped to conduct a survey next year to find out the individual severity of these diseases.

Rosette incidence did not appear to be unduly high.

There were several reports from the Northern Province of numerous "pops" (fully formed shells with no seed or the shrivelled remnants of seed) occurring in different districts. Cultural studies revealed the presence of both *Aspergillus* and *Fusarium* on the pods and nuts. It is not thought that these pathogens were responsible for the disease, which was probably caused by a deficiency of lime or magnesium. There were no reports from the Central or Southern Provinces.

TOBACCO

During the year, Dr. B. E. J. Wheeler of the Colonial Pool of Plant Pathologists, completed his studies on *Alternaria longipes* (Ell et. Ev.) Mason. Opportunity was taken of Dr. Wheeler's presence to observe the behaviour of the fungus under different experimental conditions in the field. The experiments completed showed that the destructive leaf spotting caused by this fungus can be controlled by using fertilizers with a high PK/N ratio, ploughing in tobacco trash thoroughly, preventing any regrowths, avoiding heavier sandy clay loam soils, and never planting two consecutive crops of tobacco in the same lands. [The full Report is being published elsewhere.]

Alternaria leaf spot incidence in the Kasungu area, where the experimental work was done, was lower than in previous years, but a survey of the Southern Province areas showed that the incidence of this leaf spot in these areas was higher than had heretofore been suspected.

Frog eye spot, caused by *Cercospora nicotianae* Ell et Ev., was widespread, particularly in the Southern Province, and in some lands caused considerable leaf spotting.

Mosaic incidence was generally higher in the Southern Province flue-cured crop than in the Central Province. No other virus disease was observed in amounts necessary to cause economic damage.

Sunscorch and a physiological spotting did some damage to the flue-cured crop locally in the Southern Province, this being due to the uneven rainfall and short droughts during January and February which occurred in some areas.

Alternaria longipes occurred on some fire-cured tobacco, which had been over fertilized with sulphate of ammonia, and some cured tobacco was also found with incipient *Cercospora nicotianae* infection which had led to barn spotting.

COFFEE

Coffee rust, *Hemileia vastatrix* Berk and Br. was recorded in the coffee gardens of the Misuku Hills for the first time. The outbreak was widespread, and is threatening to become serious unless recommended control measures can be adopted. As coffee is frequently grown under banana shade which is never thinned out to reasonable proportions, it has been recommended that bananas are prohibited as shade. It is also desirable that the level of cultivation be improved to maintain the trees in good health.

A collar rot and wilt of coffee at Nchenachena was investigated. One fungus found to be present was *Fusarium stilboides* Wr. (*F. lateritium* v. *longum* Storey's Form A1.). It is thought that a contributory factor in the disease is a localized water logging giving a "wet feet" condition. The disease differs from the East African form in that infection appears to originate in the stem at soil level, eventually killing the whole tree, and very rarely are individual branches affected.

Severe dieback of coffee in one area was ascribed to *Colletotrichum coffeanum* Noack.

TUNG

Armillaria mellea (Fr.) Quel. was the most serious fungus pathogen. Losses in tung on the Vipya were estimated as high as 15 per cent. in some cases. Normal practice is the ringbarking of all trees in an area of virgin woodland some two years before felling, followed by careful clearing. Despite these measures, a certain amount of *Armillaria* infected roots remain, and once it is established in an orchard, it is found impossible to eradicate, as no satisfactory measures practicable under Nyasaland conditions exist as yet.

A certain amount of dieback, due principally to *Botryosphaeria ribis* Grossenb. and Dugg., occurred all over the tung growing areas, and appears to be worse in neglected tung.

COTTON

The cyclone Edith in April created ideal climatic conditions for the spread of *Xanthomonas malvacearum* in the rain grown cotton districts. A late attack, particularly of the black arm phase, caused loss of crop in both the Salima and Lower River areas.

COCONUTS

A disease of coconut seedlings and young trees in which the trees wilt and die anything from one month to two years after planting out was investigated with the Ecologist. Physiological conditions, connected with soil type and water level, were found to be primary causes of this disease.

FRUIT

GRANADILLAS. With increase in commercial granadilla growing, as the result of the opening of a juice extraction factory in Blantyre, it can be expected that diseases would also increase. *Glomerella cingulata* (Stonem.) Spauld and Schrenk was associated with a dieback and leaf spot causing significant amounts of damage in Cholo.

Fusarium oxysporum sensu Snyder and Hansen was isolated from the collar region of a granadilla plant which had wilted and died. The disease characteristically gives the stem, at and immediately below soil level, a rotted appearance. Occasionally sunken brown lesions, on which the bark cracks and finally flakes off, extend up the stem from soil level. Plants which had been cut right back appeared to suffer most, dying shortly after putting out the new flush of growth. Dead or dying plants were also attacked by termites, particularly during the dry season.

Another wilt causing death was found to be due to *Armillaria mellea* (Fr.) Quel.

BANANAS

Mycosphaerella musicola Leach was found in an isolated area in the Nkata Bay District. At the present moment an attempt is being made to ascertain how widespread the disease is.

MISCELLANEOUS

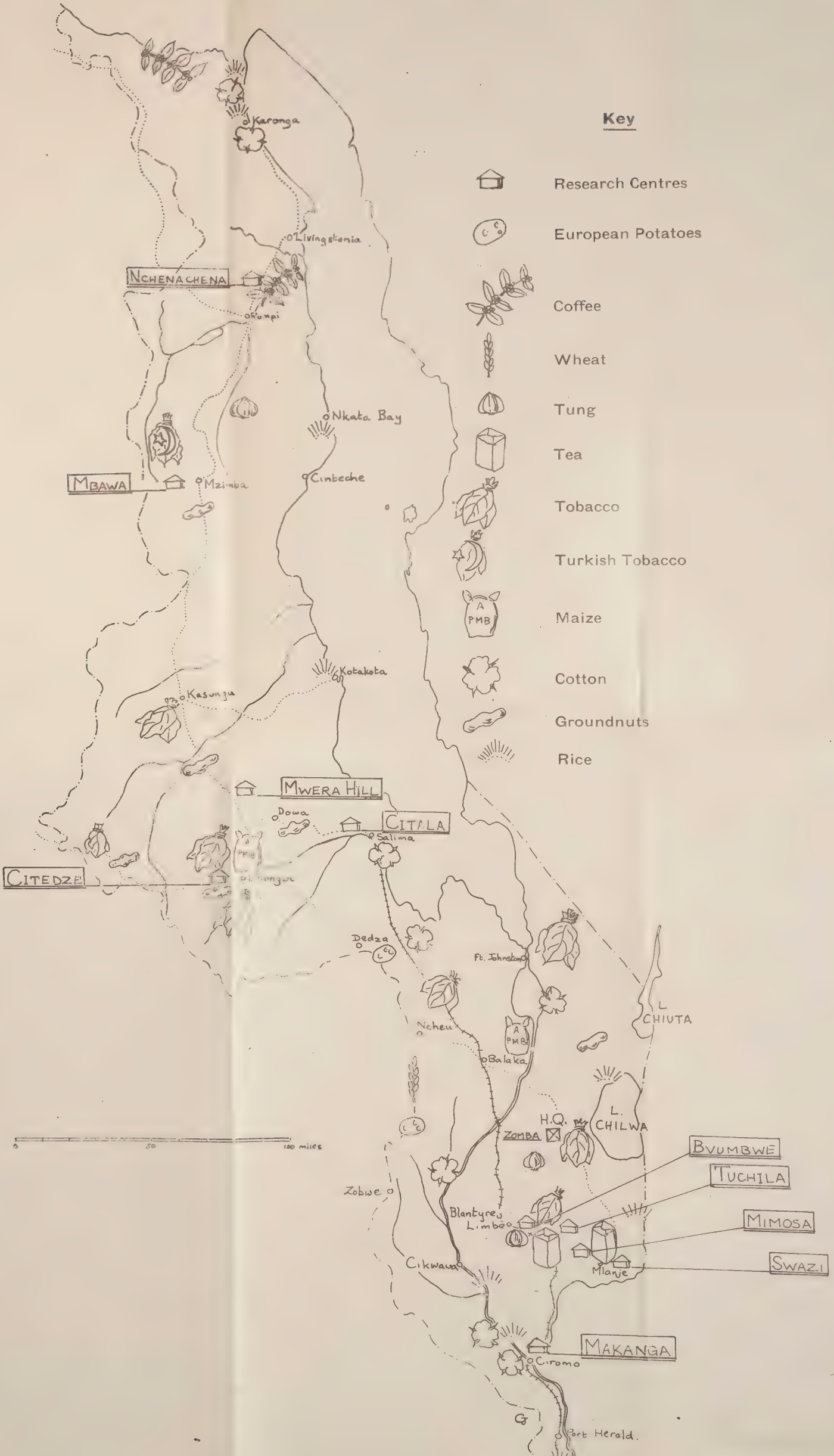
The Pathologist attended the inaugural meeting of the Phytosanitary Committee in Salisbury. The Committee has been formed to produce Phytosanitary regulations applicable to the Federation, thus making the Federation one unit as far as plant import and export control is concerned.

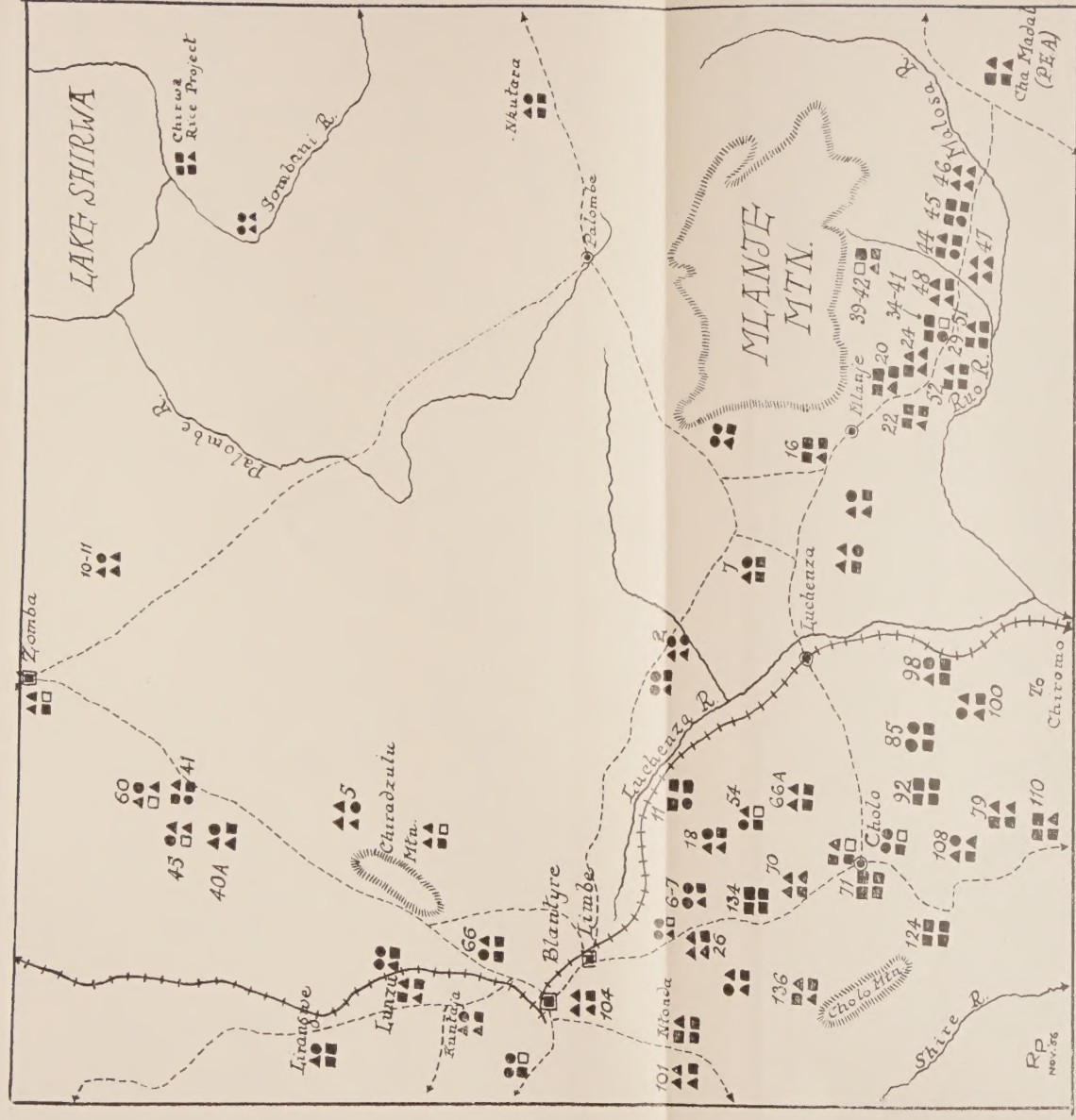
The following legislation connected with plant disease was passed during the year:—

Government Notice No. 116, concerning import of tea seed and tea plants, introduced as an amendment of General Notice No. 13 of 1950.

ACKNOWLEDGEMENTS

The Pathologist is indebted to the Director and staff of the Commonwealth Mycological Institute for their help in identification of pathogens, and to Dr. G. R. Bates his and staff in Salisbury for help and advice willingly given.





NUTRIENT STATUS MAP OF THE SHIRE HIGHLANDS

Legend

~ River
+ Railway
--- Road

~ Nutrient status: ● Low ▲ Medium ■ High □ Very high
Nutrients indicated by position viz. KP e.g. ^{CN} ● □ denotes high

C, medium N, low K, very high P
(See text)

Note: numbers refer to estates as recorded by Dept. of Lands.

